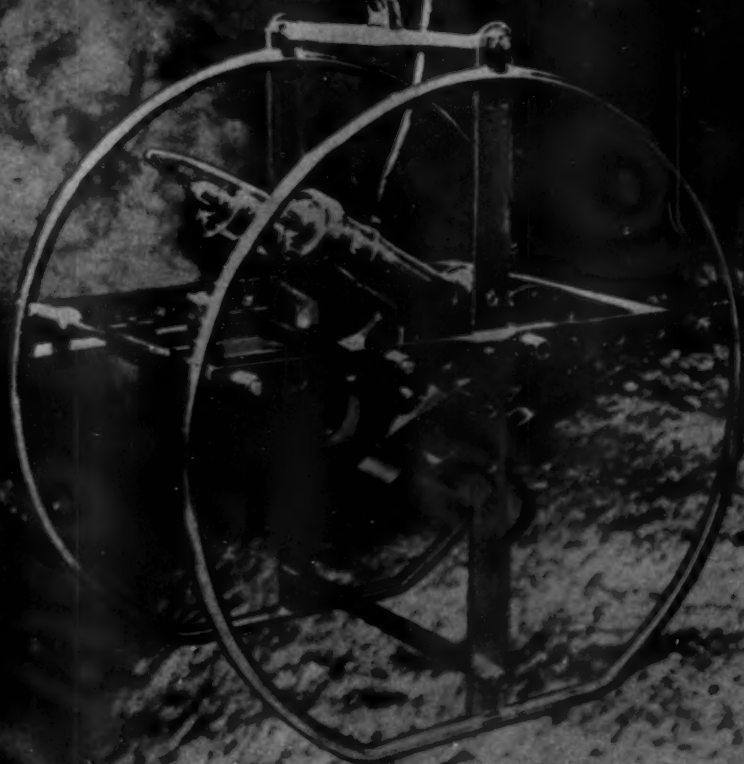
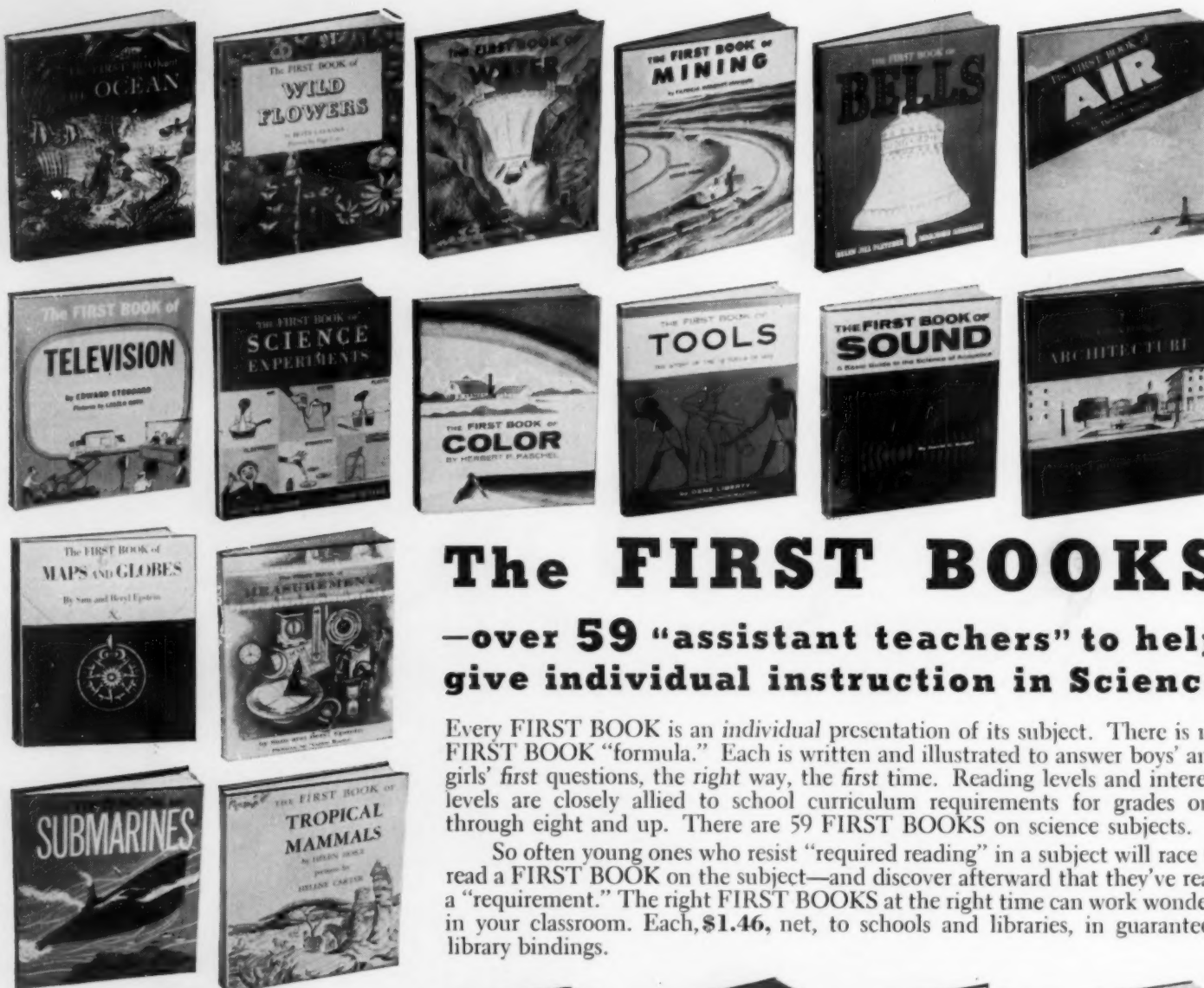


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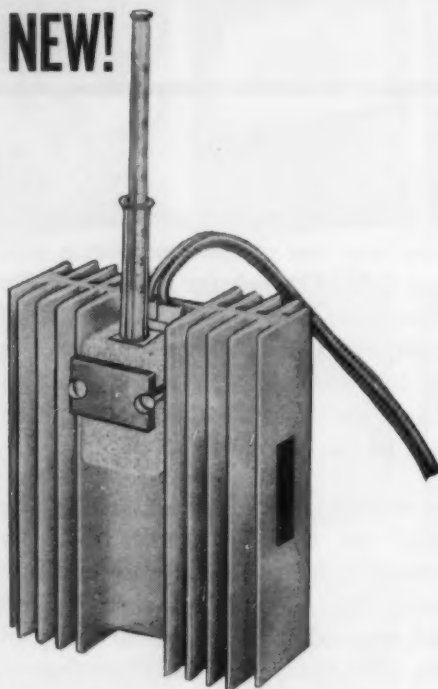
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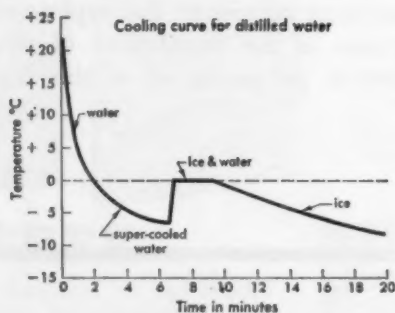
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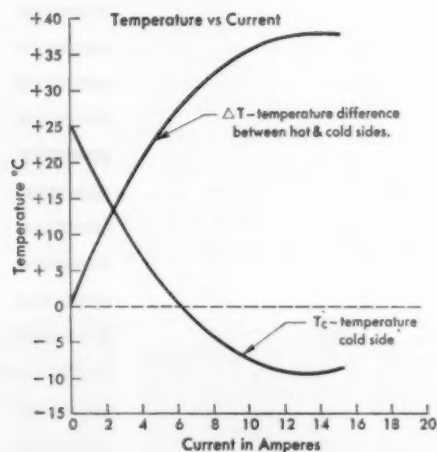
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The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

Journal of the National Science Teachers Association Volume 28, Number 6 • October 1961

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Editorial

Recently our Association was invited to have representation on an advisory group assembled by the International Cooperation Administration (ICA) to make recommendations for improving elementary and secondary science education programs in the developing nations. In an opening address, Ralph W. Ruffner, Director of the ICA Office of Educational Services, urged all to bear in mind that educational problems in the developing countries arise from a complex of needs related to individual and community living and economic, social, and political development and growth. He then cautioned us against repeating "major errors I have known" made by outsiders in their efforts to identify the most compelling educational problems in these countries. He listed five types of errors, as follows:

1. The transfer of a problem.
2. Mistaking the hull for the kernel.
3. Assuming that an educational problem can be met only with an educational solution.
4. The error of creating the problem out of the solution.
5. The panacea error.

The Problem Areas

As I pondered these cautions during our discussions, I was struck by a realization of their pertinence to problems of improving science education right here in our own country. It is hoped that this summary will be of benefit to science teachers and that each will derive some direction in meeting our goals. For example:

Error Number 1—assuming that my problem is your problem. Developing a program for elementary science, or a course in biology, or a K-12 plan for science in Milbridge, Maine does not solve a problem in Phoenix, Arizona. It is just too easy to generalize and assume that because a situation or problem of particular character and dimensions exists in A, then it must also exist in B and C. Many of the critics and some of those directly engaged in course or curriculum development seem not to realize that "the problem" is not the same everywhere, that adaptations of "the solution" are required.

Error Number 2—assuming, for example, that to lift biology out of grade ten and to put it into grade nine solves the problem. This mistaking of the hull for the kernel results when there is only superficial examination of the real or total problem. Improving science education through revision of the content and sequence of courses requires

consideration of the complete K-12 program. To go at the job piecemeal may be another example of working with the hull rather than the kernel. NSTA's Curriculum Committee is concerning itself with the total science program, rather than separate courses or grade levels in isolation from all the rest.

Error Number 3—assuming that educational problems must have educational answers. Experienced school people know that quite often the roots of certain difficulties reside in social, economic, religious, or other factors that operate in the community or among the school population. Matters of health, attitudes toward going to college, incidence of deviate behavior, and others, more often than not, will be changed through communication and cooperation with other agencies, not by schools alone. Sometimes educational problems cannot really be solved until other, more basic adjustments are brought about.

Error Number 4—following a bias to the point of creating a problem out of a "pet solution." Often this takes, and gets, a lot of selling. Here is a device or plan or procedure that worked beautifully in meeting a problem in school or community X; therefore, you must have a similar problem amenable to the same solution. It is possible, of course, that in Y and Z there is no need for this answer; perhaps for them the problem does not really exist.

Error Number 5—assuming that no matter what the problem is, *this* is the answer. It is one thing to be enthusiastic about new or different approaches or devices, and then quite another to advocate them as panaceas without limitations or specialized applications. Perhaps you, too, recall when the workbook was the panacea to solve all the problems of large classes, individualized instruction, limited facilities, etc. We can easily fall into this error over films, television, programmed instruction, kits, and similar devices if we are not careful.

Summary

I suppose all of this adds up to the notion that teachers and others concerned with curriculum and instruction cannot abdicate the responsibilities of analyzing and solving their own problems. It is true, of course, that many agencies and individuals have much to offer. But if education in science for all youth is to be planned and provided most effectively, the best talents and resources available must be combined and directed *under educational leadership*; moreover, they must be focused on the truly significant objectives and problems of the local school or school system. At long last, there is gratifying concern to build for greater excellence in education. It is difficult to conceive, however, how this can be done "off-campus" through national curricula, or TV, or films, or whatnot—any more than the educational problems of the developing countries can be solved solely by panels assembled in Washington, D. C.

Robert H. Carleton

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THE SCIENCE TEACHER



As editors for State Science Teacher Associations, we find it helpful to exchange with other editors, and would like to alert state associations to write us in order to establish an exchange of data.

We have copies of our Newsletters and other publications which might be helpful to other states. It would be of use to us in keeping up with what the many state associations are doing. If you can publish this for me, perhaps we can get the names of editors who would like to initiate this exchange. Just have them write to the address below.

GENE DOTY, *Editor*
OSTA Newsletter
Hillsboro Union High School
Hillsboro, Oregon

The FSA Science Club has been spurred to plan a number of calendar events for the forthcoming year.

So far we have had lecturers from the Quilcene Shellfish Laboratory. We saw a film telling about the principles of oyster fertilization and development, and learned about the equipment used by a marine biologist. We have a number of trips planned for the future to the Shellfish Laboratory, and are scheduled to visit other research institutions.

The enthusiasm comes from the members and already projects are being started with much interest.

MICHEAL BROMLEY
Port Townsend High School
Port Townsend, Washington

Annual Joint Meeting of NSTA

with other Science Teaching Societies . . .

At the 128th Meeting of the American Association
for the Advancement of Science

December 26-30, 1961, Denver, Colorado

. . . See Page 61

NEA NOTES

EDITOR'S NOTE: From time to time, we will report events and data of interest from the other NEA units in this column. Additional information on the items reported may be obtained by writing the individual groups listed under each item.

Health Education in the United States

The American Association for Health, Physical Education, and Recreation, a department of the National Education Association, has undertaken a comprehensive project, which seeks to determine the nature and scope of health teaching in kindergarten through the twelfth grade. The purposes of the study include the measuring of attitudes and knowledge of selected samples of school children; and the determining of their health needs, methods of learning, and ways their attitudes and behavior can be changed. Consideration will be given also to the health knowledge an individual should possess for intelligent living in the world today.

An initial grant of \$55,000 has been made by the Samuel Bronfman Foundation of New York City. For information write to the AAHPER, 1201 Sixteenth Street, N. W., Washington 6, D. C.

NEA Catalog of Publications

The current Catalog of NEA Publications for 1961-62 contains a valuable listing of items prepared as a service to the teaching professions. The new catalog (40 pages) includes an alphabetical title index and a special listing of many of the recent publications

just off the press. These are shown in a second color for easy reference. There are listings of books, pamphlets, periodicals, education proceedings, research reports, and audio-visual materials. An initial free distribution has been made to key groups in education. A limited number of free copies are available upon request to the Publications Division of the National Education Association, 1201 Sixteenth Street, N. W., Washington 6, D. C.

Elementary Education

Elementary Education and the Academically Talented Pupil is the tenth publication of a series produced by the National Education Association's project on the Academically Talented Student. The 96-page book was prepared through the cooperation of the NEA Department of Elementary School Principals. This publication takes a look at the problem of meeting the needs of that portion of our elementary school population which may be identified as academically talented and studies the matter of providing adequately for them. It stresses first that a good school program for all children is a vital concern of elementary school educators. Copies of the booklet may be obtained by ordering from NEA, 1201 Sixteenth Street, N. W., Washington 6, D. C. Single copy \$1. (Order by stock No. 50-109.)

New NEA Television Series

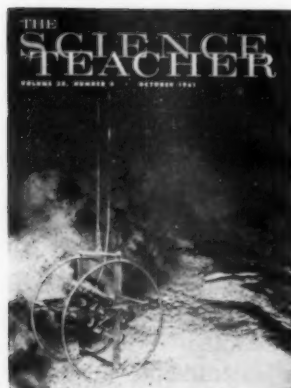
The National Education Association continues its television packaging with a new 13-week half-hour TV film series entitled *Parents Ask About School*. These films are produced and presented by the NEA and its affiliated state education associations and are designed to acquaint Americans with the problems, purposes, and progress of education. The theme grew out of a survey of questions parents are currently asking about their children's education.

Eight of the 1961 films cover such topics as discipline, the drop-out, testing, elementary education, adult education, the academically talented, and school financing breakthroughs. The other seven films are based on the questions parents are asking; i.e., "What is a teaching machine?" "Should my boy learn French in the fourth grade?" Answers are given by education experts—classroom teachers, principals, superintendents, and college professors—from all over the U. S. For brochure or additional information, write to: Division of Press and Radio, NEA, 1201 Sixteenth Street, N. W., Washington 6, D. C.

THIS MONTH'S COVER . . .

Activity on the Pacific Ocean floor is recorded by the author of this month's lead article (page 6) with a U. S. Navy Deep Sea Camera, the Edgerton.

When the camera is placed in position, the disturbance causes the fine sediment of the ocean floor to swirl up in clouds, but this later settles back slowly to form microrelief. The light of the camera reveals marks and tracks made by benthonic life normally found at the sea bottom. (The first published photographs of underwater environment were released for TST by the U. S. Navy Electronics Laboratory, San Diego, California.)



MICRORELIEF. ON



FIGURE 1. Sunda Sea Basin, North of Sumbawa, Indonesia. The churned mud bottom shows a large brittle star and numerous small spiny sea cucumbers. The sediment-water interface is a sharp contact surface showing scratches, tracks, and grooves made by crawling and burrowing organisms. The camera shot at a depth of 2090 meters took in a one square meter area (only one-half of this area is shown).

SINCE the beginning of history the floor of the deep sea has been considered by man as a dark and mysterious realm and virtually inaccessible to his view. Actually, the millions of tons of sea water that guard this region have done it effectively until just recent times. For the early mariner sailing the seas in search of economic trade, only the upper layers of the oceans and the shallow coastlines, channels, bars, inlets, and harbors near the shore were of immediate concern. His curiosity, concerning knowledge of the deeper areas although evident, was limited by the instruments available;

N THE SEA FLOOR

By **CARL J. SHIPEK**

Oceanographer, U.S. Navy Electronics Laboratory, San Diego, California

in particular, the use of a relatively short length lead-weighted sounding line. Occasional samples of harbor and coastal muds adhering to this lead weight served to help locate his vessel and keep it in safe waters. Beyond this, there was no application.

Early scientific explorers developed a tremendous respect for the vast ocean with its wind-stirred surface that continually hindered efforts to penetrate

the deeper areas. Position-finding methods were, at first, primitive and this, together with poor depth-finding and bottom-sampling equipment, limited investigations to shoal areas and to the continental fringes of the oceans. By 1872, however, successful methods of dredging and sampling at great depths had been developed. They were fully utilized during the oceanographic research expedition on the ship,

The author-photographer was assigned to the U. S. Navy research expedition "Monsoon" to the Indian Ocean during 1960-61. The group operated from the Research Vessel, "Argo," of Scripps Institution of Oceanography, La Jolla, California. Illustrated are the first published photographs made during the expedition.

The oceanographer, Mr. Shippek, first came to the attention of the editors when he received one of the Bausch and Lomb Photogrammetric Awards at the Twenty-sixth Annual Meeting of the American Society of Photogrammetry (1960) for his outstanding work of camera survey of the deep.

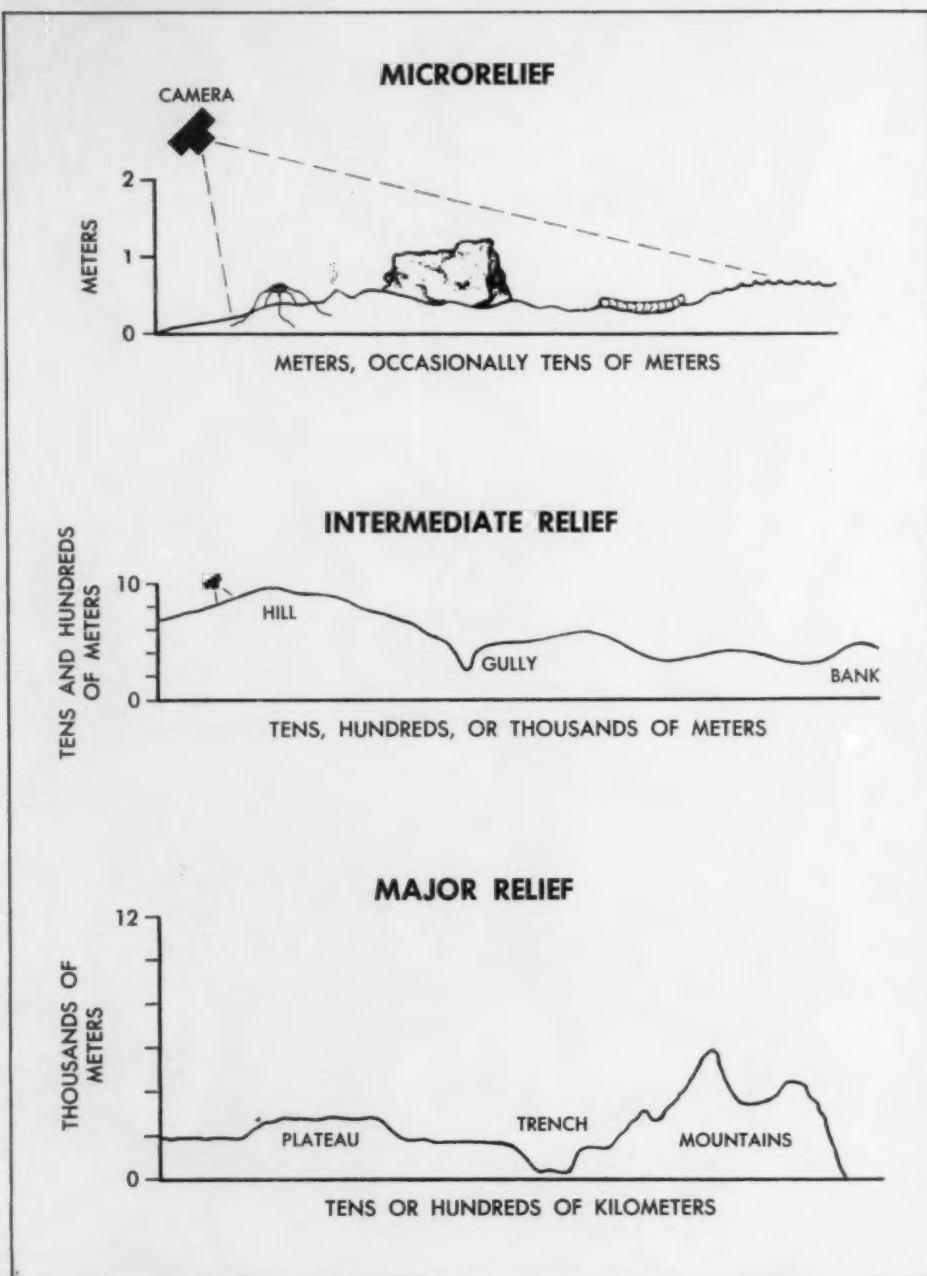


FIGURE 2. Microrelief, Intermediate Relief, and Major Relief.

Challenger, sailing that year, and many marvelous objects including manganese nodules, sharks teeth, whale earbones and other items were brought up from depths in excess of 5000 meters (16,405 feet). These discoveries were of considerable scientific value and tremendously stimulated man's growing interest in the water depths yet unknown. A number of such oceanographic expeditions each with successively better equipment, and larger research vessels, followed to pave the way for modern research programs.

Of all the many instruments developed to assist the deep-sea explorer,

the Echo Sounder was perhaps the most important. Utilizing the speed of sound and its function in water, or the action of radar in air, this instrument was able to record continuous profiles of sea floor relief. For the first time topographic features in the deep ocean could be delineated and mapped for general use. This put an end to archaic and superstitious beliefs of bottomless deeps, trenches, holes, and featureless expanses of smooth sea floor. In addition, this was the first time that the actual change from water to sediment could be traced through all submarine environments and especially down into

deep water. To examine this underwater boundary more completely, some means of photographic observation were needed. During World War II some underwater photographic equipment had been developed to search for and identify military targets beyond the reach of divers. Lowering of equipment was limited to shoal areas, but a few scientists saw the potential of an effective deep-sea camera.¹ By 1950 special cameras had been designed and constructed to investigate the properties of unconsolidated sediments, and to study the physical, biological, and chemical processes going on at the sea bottom and in the waters overhead. A wide variety of sea floor environments was examined photographically with the special newly made cameras in select areas of the Pacific Ocean. Recently, a number of sea floor areas in the Indian Ocean were photographed with cameras giving both single shot and stereo coverage. The measurable surficial relief (microrelief), resulting from bottom current activity, benthonic animal churning in soft sediment, and the precipitation of manganese crusting and nodules, was measured and compared to similar relief on the floor of the Pacific Ocean. A selected group of photographs taken from the ocean bottom are being published to show the microrelief which was found. This discovery is expected to facilitate in the probing of "inner space." Through the newly developed camera (analogous to the rocket vehicle for space) and the deep diving bathyscaphe, unknown depths of yesterday are now being explored. The oceanographic information uncovered may lead more to the utilization of the ocean depths for resources now needed in everyday living, as well as for military and economic purposes.

Transition from Water to Sediment

Until recently, many scientists believed that the transition from water to sediment in the deep oceans was a "soupy" zone of organic and inorganic materials gradually grading downward from clear water into semiconsolidated sediments. The Deep-Sea Camera has dispelled this belief, and the recent photographs show that this zone is actually a plane (area) of sharp contact (Figure 1). We, therefore, can

¹ Henry W. Menard. "Deep Ripple Marks in the Sea." *Journal of Sedimentary Petrology*, 22:3-9. March 1953.

define the sediment-water contact as the irregular but definite plane of demarcation or discontinuity that lies between the overhead waters and the materials making up the sea floor. This plane is also called the "interface." It has been found too, that often recently deposited sediments grade evenly downward into consolidated sediments of older age. Sometimes current or wave washed deep-sea surfaces have been cleaned of fine materials leaving behind coarse sediments or gravels called "lag" deposits. The camera has revealed also bare bedrock lying exposed at great depths. Below 200 meters, a region of nearly total darkness extends to the sea floor except for infinitesimal amounts of light emanating from pelagic fishes and other creatures with small organic light cells like fireflies. Unless used for sensing requirements, this light is insufficient for practical photographic use. Thus all deep-sea cameras should be provided with their own artificial light sources.

For the photographer, these points are made. Provided that the sediment at the interface is not stirred up before photographs are taken, target distances will normally vary from approximately two to four meters for present-day cameras. (High attenuation of light by absorption and scattering in sea water limits photography to these distances.) The type of camera lens utilized will determine the angular coverage and resulting target area. Normally, a semi-wide angle lens, set at two meters underwater, thirty degrees from the vertical, will give a subject coverage of approximately two square meters. This coverage can be increased to approximately six square meters by increasing the target distance to about four meters or by changing the target angle to about ten degrees from the horizontal. Water immediately above the interface in the deep oceans is somewhat more transparent than coastal water at shoaler depths, but even in the clearest water, with powerful lights for illumination, photography is limited to relatively short distances, and thus can include only small areas of coverage.

We must remember that the interface extends from the shallow littoral environments to the abyssal depths and through all bodies of water. For the camera, with coverage capacities described, to photograph the complete interface is of course an impossible

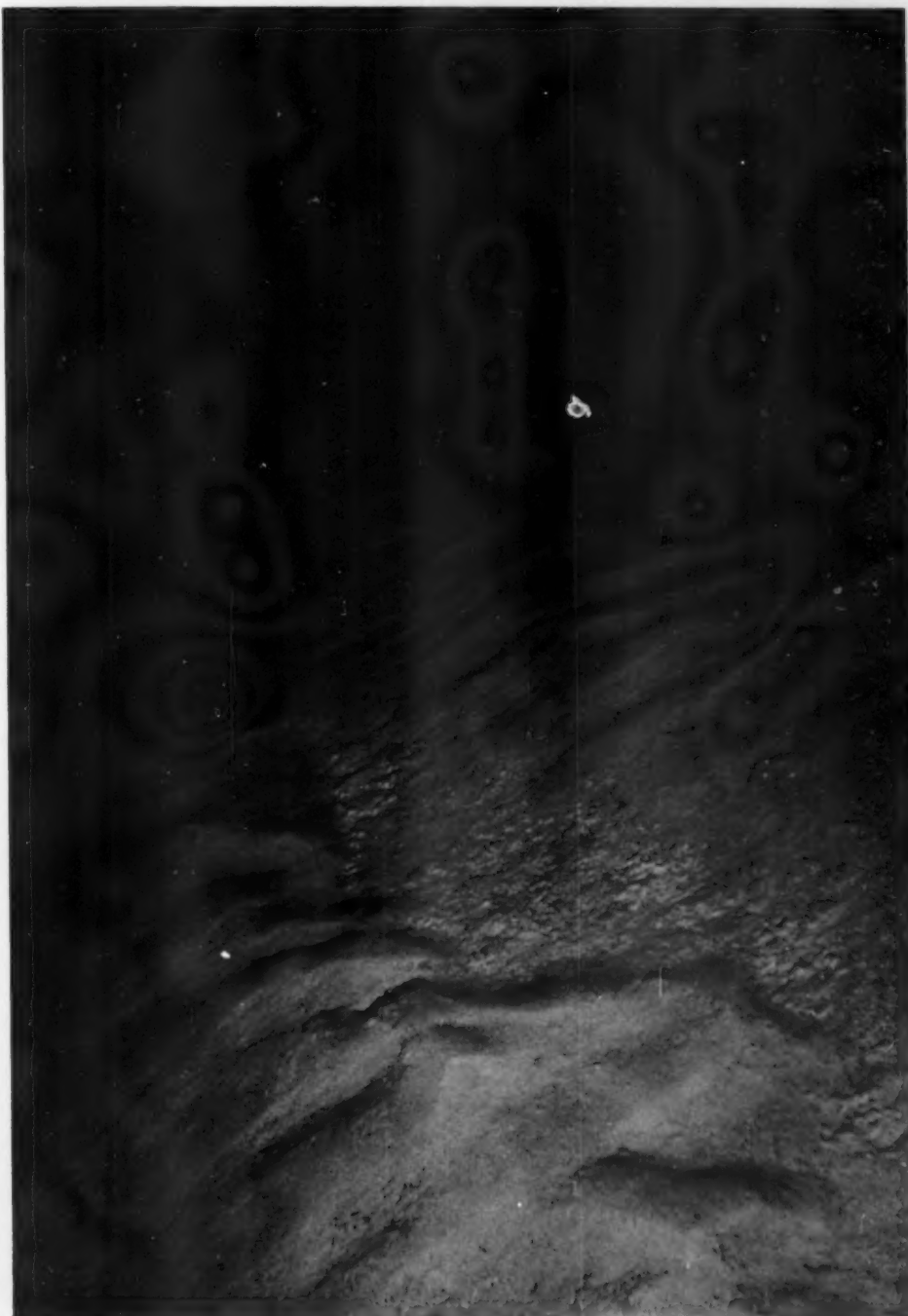
task. Selection of study areas is therefore extremely important to obtain useful data. To properly examine the microrelief of the interface, we must first define the topographic relief that extends for thousands of miles underwater. Basically, submarine relief may be divided into three types (Figure 2).

Major relief naturally encompasses the larger earth features of great extent such as deep trenches, high plateaus,

rises, isolated mountains, and widespread topographic highs. They are all measured horizontally in tens or hundreds of kilometers and thousands of meters vertically. These features are many times too large to be photographed with the deep-sea camera.

Intermediate relief describes the smaller topographic features such as low hills, valleys, channels, levees, gulches, banks, and small canyons that may

FIGURE 3. Western Indian Ocean. The upper surface of a topographical high, at a depth of 2810 meters. Large ripple marks, formed in coarse sand and cross-rippled by weaker oscillatory currents, may be seen. Note the accumulation of coarser particles in the troughs of the large ripple marks. (The photograph area is approximately three square meters.)



be part of major features. Measured horizontally in tens, hundreds or thousands of meters, and vertically in tens and hundreds of meters; these minor features are still too large to be photographed in their entirety with underwater cameras.

Microrelief, as mentioned in a previous paragraph, describes the very small, surficial, topographic features that are

superimposed on both major and minor relief and are distinguishable by examination of bottom photographs, and the surfaces of undisturbed sediment samples. Microrelief is usually the direct result of the natural processes working on bedrock and sediments at the interface and is measured horizontally in meters and tens of meters, and vertically in centimeters and

meters. Although varying considerably, microrelief is all inclusive and extensive, whereas intermediate and even major relief features may be localized or extremely discontinuous.

The natural processes mentioned above are best divided into physical, biological, and chemical forces. Singly, together, or in opposition, they operate endlessly to determine the microrelief.

Physical Processes

These processes usually comprise the discontinuous effects of deep translatory or oscillatory currents on bottom-forming materials. Extremely fine-grained sediments such as clay and soft ooze are not easily moved by bottom currents regardless of velocity; but fine sands, grading through coarse sands, and granules can be rippled by currents having a velocity of approximately 30 to 90 cm/sec (about 0.7 to 2.0 mph). Numerous ripple marks like those shown in Figure 3 are the result of this type of action which is common on submarine highs, seamounts, marine terraces, and other similar features where currents are found. At velocities much above 90 cm/sec, ripple marks disappear even in the very coarse sands. Current and wave action of submarine origin disturbs and sorts sand grains of different specific gravities and moves enormous quantities of fine-grained materials down slope into deeper waters for redeposition.

Biological Processes

When bottom materials are soft and rich in organic matter, benthonic (bottom dwelling) organisms are numerous at and below the interface. They churn and disrupt the normal deposition of sediments in their search for food. Crawling, burrowing, and plowing creatures probably cause the greatest overturning of recently deposited sediments (see Figures 4 and 5). Worms that burrow below the surface of the bottom leave mounds and holes, or while crawling at the interface, digest clay, ooze, or sand directly. They sort out the contained organic materials internally leaving fine, irregular trails and piles or ribbons of excrement. Gastropods, or snail-like animals, crawl at the surface and form typical plow trails. Echinoids (sea urchins), ophiuroids (brittle stars), and various species of crustaceans (mostly decapods, crabs and shrimp) crawl or walk along on

FIGURE 4. Central Indian Ocean. At a depth of 1740 meters, large bottom mound is seen surrounded by peculiar current scour pits. Note the small mounds in the lower left-hand corner with sutured crests. The radial pattern nearby is a grooved search pattern left by a worm which has come out of the central hole looking for food. (The photograph area is approximately three square meters.)





FIGURE 5. Indian Ocean. Location in the northeast of Cocos Keeling. Depth 5100 meters. The churned red clay bottom is marked by typical mounds, a worm, and worm excrement. The origin of the two spherical balls is not known, but they are believed to be Ascidians (low form of spherical invertebrate having only gill slits and attached to the bottom). Study of these various forms leads to new knowledge of underwater life. (The photograph area is approximately three square meters.)

the bottom leaving scratches, grooves, marks, etc. At times, such animal activity assists currents and waves in the down-slope movement of materials to deeper water. It is not uncommon for current or wave action to completely destroy tracks, trails, and marks as rapidly as they are formed by organisms.

Chemical Processes

Mineral-rich waters passing over the sea floor under the influence of high oxygen content at critical temperatures lead to the precipitation of iron and manganese oxide nodules at the inter-

face.² Measurable microrelief results from the growth of these nodules; sometimes they coalesce to create irregular patches of nodular material on the sea floor (Figure 6).

When rates of sediment accumulation are relatively high with respect to rates of chemical precipitation, the nodules are masked by sediment accumulation. When the converse is true, the dark nodules will stand out in sharp

² Carl J. Shippek. "Photographic Study of Some Deep Sea Floor Environments in the Eastern Pacific." *Bulletin of the Geological Society of America*, 71:1067-74. July 1960.

contrast and microrelief which is apparent above the interface.

Interpretation of Photographs

A successful camera survey of a sea floor area depends upon accurate and imaginative photo interpretation. Because of the relative inaccessibility of the sea floor and the expense and physical difficulty in actually procuring the bottom photographs, it is vital to carefully decipher all visible photographic targets by measurements and comparison with known information, based on studies of environmental specimens. For reasons of economy alone it is necessary to extract the last iota of useful information.

Wave studies along our coasts and studies of currents in flumes have produced considerable information of value and provide a basis for comparison on the movement of sediments underwater.³ Thus the photographic disclosure of symmetrical ripple marks in a medium sand at a depth of 2000 meters tells the scientific investigator that an oscillatory current with a velocity of approximately 40 to 50 cm per/sec is thus probably producing the ripple pattern visible in the photograph. Knowing that medium sand has a ripple index of about 15,

$$(\text{Ripple Index} = \frac{\lambda \text{ wave length}}{N \text{ wave height}}),$$

a ripple mark having a measured wave length of 38 cm will have a wave height of 2.5 cm.

If both wave length and wave height can be measured in a photograph, the Ripple Index can be calculated, which in turn will give the grain size of the rippled sand and the velocity at which the ripple formed.

Knowing also that there are minimum and maximum velocity values above which and below which sand grains cannot be moved by a current, it is possible by photographic interpretation to predict grain sizes from wave lengths and the velocities of unseen currents moving over the sea floor. If ripple marks are asymmetrical in shape, the current has come from one direction only or is stronger in one direction than another. Larger ripple wave lengths denote coarser sands. Shorter wave lengths denote finer

³ Douglas L. Inman. *Wave-Generated Ripples in Nearshore Sand*. Technical Memorandum No. 100. U.S. Army, Corps of Engineers. October 1957.



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sands. The numerous animal tracks, plow trails, holes, pits, mounds, scratches, etc., that are clearly visible in some photographs can sometimes be directly associated with or matched to specific organisms. More often, known organisms can be associated with the impressions, markings, etc., which they generally leave behind as they move on in their search for food.

Normally the presence of organisms and their associated trails and tracks on an unrippled sediment will denote a material too fine to be rippled or moved by bottom currents.

The visible presence of manganese nodules, phosphate slabs, and manganese-impregnated pumice fragments tells us something about the general chemical condition of sea water in the area photographed and gives us clues to the slow rates of sediment accumulation, when the nodules are resting on the interface. When such nodules are lightly capped with sediments, an increase in accumulation is indicated. Fresh-looking nodule surfaces suggest an extremely low rate of sediment accumulation. The color of a manganese nodule, which is somewhat blackish, gives an indication of the chemical content of the nodule. A brownish look indicates the presence of iron whereas a bluish look indicates the presence of cobalt. Photographs taken along a plotted ship's track, corrected for set and drift, permit a general quantitation survey of minerals and animals using standard methods of distribution counting. Clear plastic overlays, with incorporated scales, permit one-foot squares to be analyzed from a series of composite bottom photos. Percentage counts from photograph to photograph for standard areas are totaled for economic or scientific requirements.

Sometimes the clarity or transparency of the bottom water itself can give clues to rates of sedimentation and the presence of deep currents. Depending upon the sediment present, clear water could be an indication of a low rate of sediment accumulation, since the very fine organic and inorganic particles remaining in the water would have extremely slow settling rates. The overhead waters for such an area are probably not rich organically and bottom current velocities are probably too weak to stir up particles already settled out of solution. In deeper regions of our oceans, only fine clays or oozes are

normally present and would therefore not move anyway, even if stronger bottom currents were present.

Conclusion

We have seen how sea floor relief varies with water content, depth, benthonic animals, currents, bottom materials, and grades of materials. The presence of nodules, loose rocks, and animals on the bottom or interface has proved that the sea floor is capable of

supporting various loads for static and moving operations. Perhaps the nations of tomorrow will include engineering or farming structures built on the micro-relief of our present ocean floors. If this seems rather fantastic in concept and remote in time, remember that water covers over 70 per cent of the earth and the remaining 30 per cent is considered by many authorities as too small to support the growing populations predicted for future centuries.

FIGURE 6. Western Indian Ocean. The upper surface of a topographical high taken at a depth of 2810 meters. The bottom is manganese encrusted. (This was taken a short distance from the location shown in Figure 3. The area is approximately three square meters.)



Memorandum

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NSTA COMMITTEE REPORT ON

The K-12 Science Program

THE NSTA Curriculum Committee established during 1959-60 undertook to examine current policy of the Association relative to the K-12 science program. With the increased emphasis by the nation to improve education at all levels, it is expedient that NSTA take action to formulate or recommend new policies which would represent Association directives for its members in carrying out the K-12 science program in our schools.

Following the NSTA Eighth National Convention at Kansas City, Missouri, certain recommendations to implement new action on this matter were submitted to the NSTA Executive Committee and the Board of Directors by the 1959-60 President, Donald G. Decker, who served also as Chairman of the K-12 Committee for the year 1959-60. Dr. Decker asserted that the Association should go on record as endorsing certain policies or programs within the following framework: that the Association should act on any recommendations in an advisory capacity; that it should formulate and suggest general criteria by which K-12 programs can be evaluated; or that it should describe what it considers to be a desirable K-12 program. With many other organizations suggesting and working toward the development of specific programs in science, the NSTA has been placed in the position of recommending one of these programs, of side-stepping the issues completely, or of developing a program of its own. As a possible solution to the various issues, the K-12 Committee recommended:

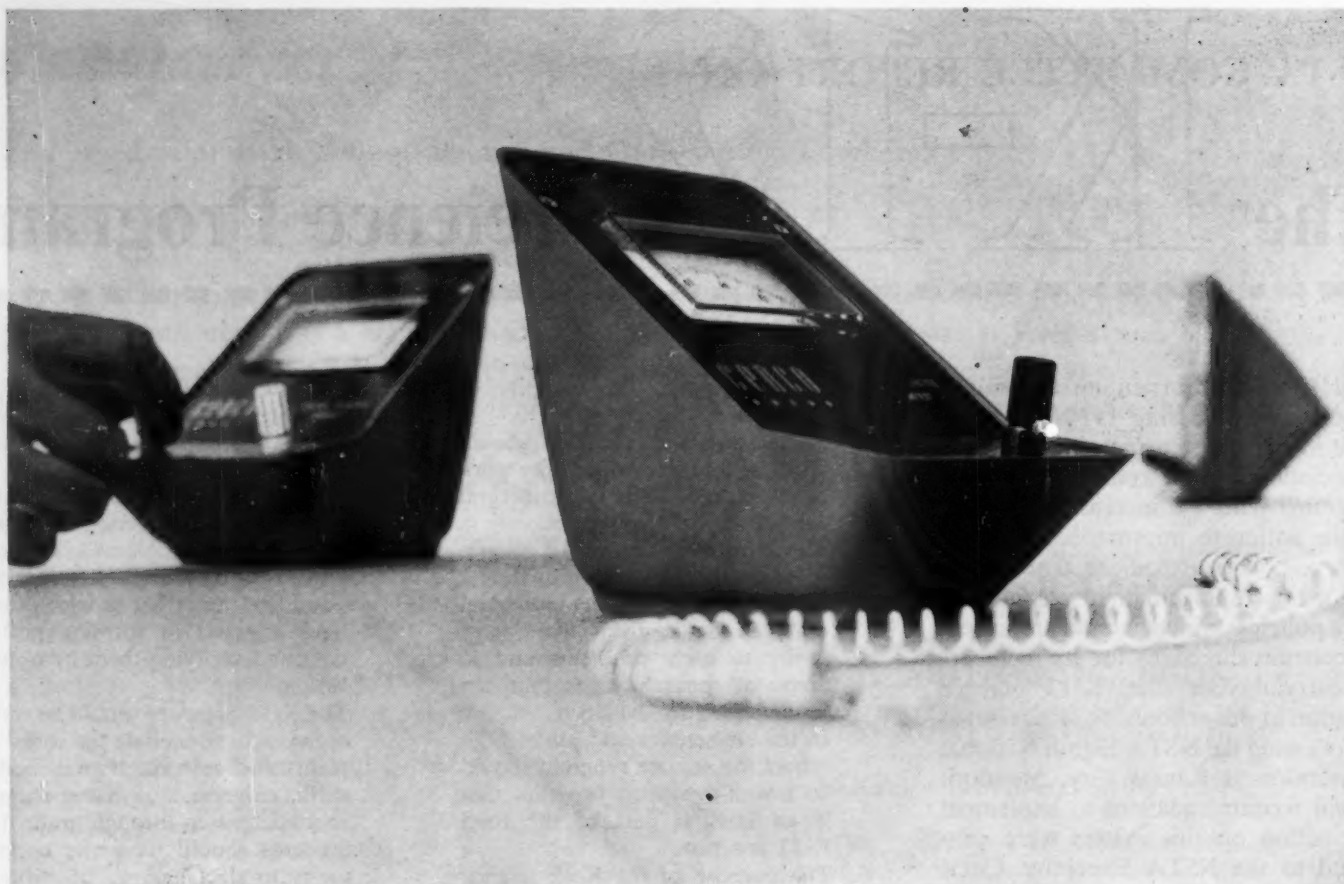
1. NSTA should describe what it considers to be a desirable K-12 science program and it should state the general criteria by which it can be evaluated.
2. A K-12 science program should be characterized by the quality of the experiences selected for students

rather than by the quantity of experiences.

3. A K-12 science program should be well-organized so that the work of each grade level is an integral part of the entire program.
4. The purpose of the K-12 science program should be the growth and development of each individual child so he is given the opportunity to solve problems and to arrive at generalizations that can be defended by evidence.
5. In the elementary and junior high school the science program should be a well-organized program that is an integral part of the total K-12 program.
6. The purpose of the K-12 science program should be the opportunity to learn the processes by which scientists formulate theories and the opportunity to engage in the intellectually creative act of thinking and formulating postulates and verifying them as the practicing scientist does.
7. Student achievement should be evaluated by discovering how well students solve problems in science, how well they understand processes, and the extent to which they have engaged in forming postulates and verifying them by observation.
8. The K-12 program should be well-organized and include the study of plants and animals, human body, earth, universe, and matter-energy in kindergarten through grade 12.
9. Students should have the opportunity to elect biology, chemistry, and physics, and advanced courses in each of the three subjects in senior high school.
10. A science program should be re-



NSTA Curriculum Steering Committee: (l. to r., Back Row) Donald G. Decker, Chairman, Delmas F. Miller, James W. Busch, Irwin L. Slesnick, and Joseph D. Novak. (l. to r., Front Row) Dorothy E. Alfke, Lois E. Dunn, and Josephine F. Bordonaro. (R. H. Carleton and E. S. Obourn, not present.)



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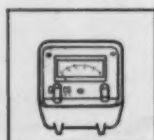
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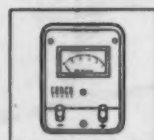
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Tipped Side View



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quired of all students in the primary, intermediate, and junior high school grades.

These recommendations concur with the opinions of the majority of the members of the National Science Teachers Association. Believing that any action taken by the organization should be representative of its membership, Dr. Decker prepared a questionnaire designed to ascertain the opinions of NSTA members. The questionnaire in its original form (Form A) was then submitted to the following groups for response and suggestions for improvement: the past presidents of NSTA; the Board of Directors of NSTA; the K-12 Committee of NSTA; the members of the New England NSTA Regional Conference at Concord, New Hampshire; and the Texas NSTA Regional Conference at Austin, Texas. Tabulation and analysis of the responses and suggestions for improvements received from these groups resulted in the first revision of the questionnaire (Form B). Form B was then submitted to the members of the Chicago NSTA Regional Conference and

to the members of the New York NSTA Regional Conference for response and suggestions for improvement. These responses and suggestions for improvement of the questionnaire were tabulated and analyzed. While both Form A and Form B were not entirely satisfactory, they did indicate that members of NSTA do have certain definite ideas.

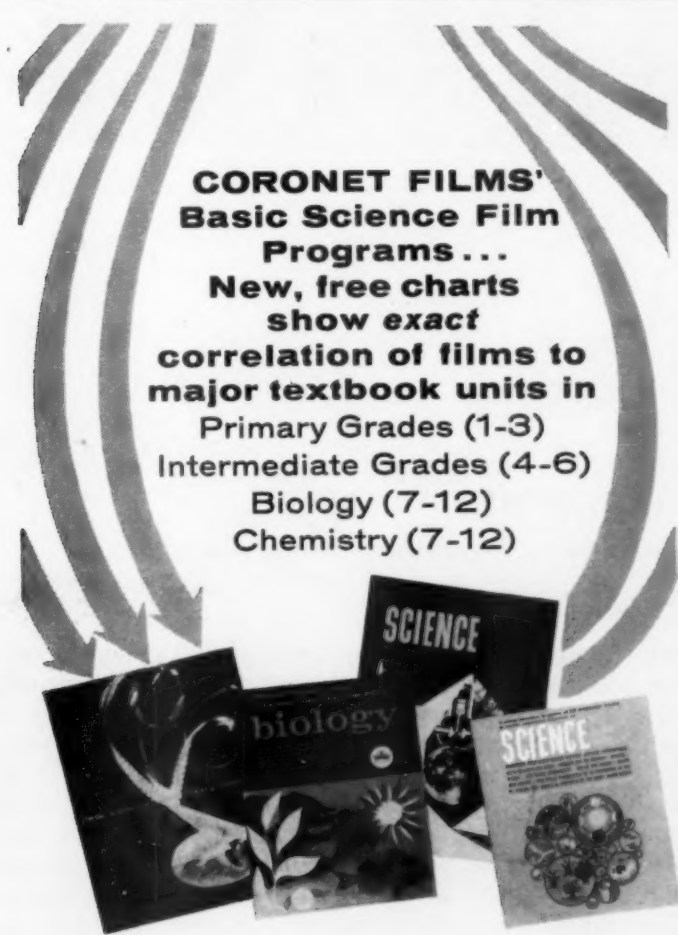
Bernard S. Cayne, initially with the Educational Testing Service, collaborating with Dr. Decker, made a study of the problem and of the weaknesses of the K-12 questionnaire. After considering the suggestions for improvement that had been made by the participating NSTA members, Mr. Cayne produced a second revision of the questionnaire which became Form C. This form was submitted to the members of the K-12 Committee, the Board of Directors, and the Past Presidents of NSTA for approval of its use at the Ninth National Convention at Kansas City (1960) to determine what the membership wants NSTA to do.

Form C was submitted to NSTA members of Montana as well as to NSTA members in attendance at the

National Convention. Forty-three science teachers of Montana and 255 NSTA members at Kansas City responded to the questionnaire. Tabulation and analysis of the data by the K-12 Committee led to the formulation of the recommendations submitted to the Board of Directors in reference to the role that NSTA should have in the K-12 science program. The recommendations were studied also in relation to Association objectives.

The K-12 Committee made three recommendations for committee work for the 1960-61 year. They were: (1) to develop a guide for K-12 science programs; (2) to duplicate the bibliography for K-12 science program courses of study; and (3) to select the committee members from those who have been engaged in the production of K-12 courses of study. (Assisting Dr. Decker in preparation of the report was graduate student Charlotte Miller.)

DONALD G. DECKER
Chairman, NSTA Curriculum
Steering Committee
Colorado State College
Greeley, Colorado



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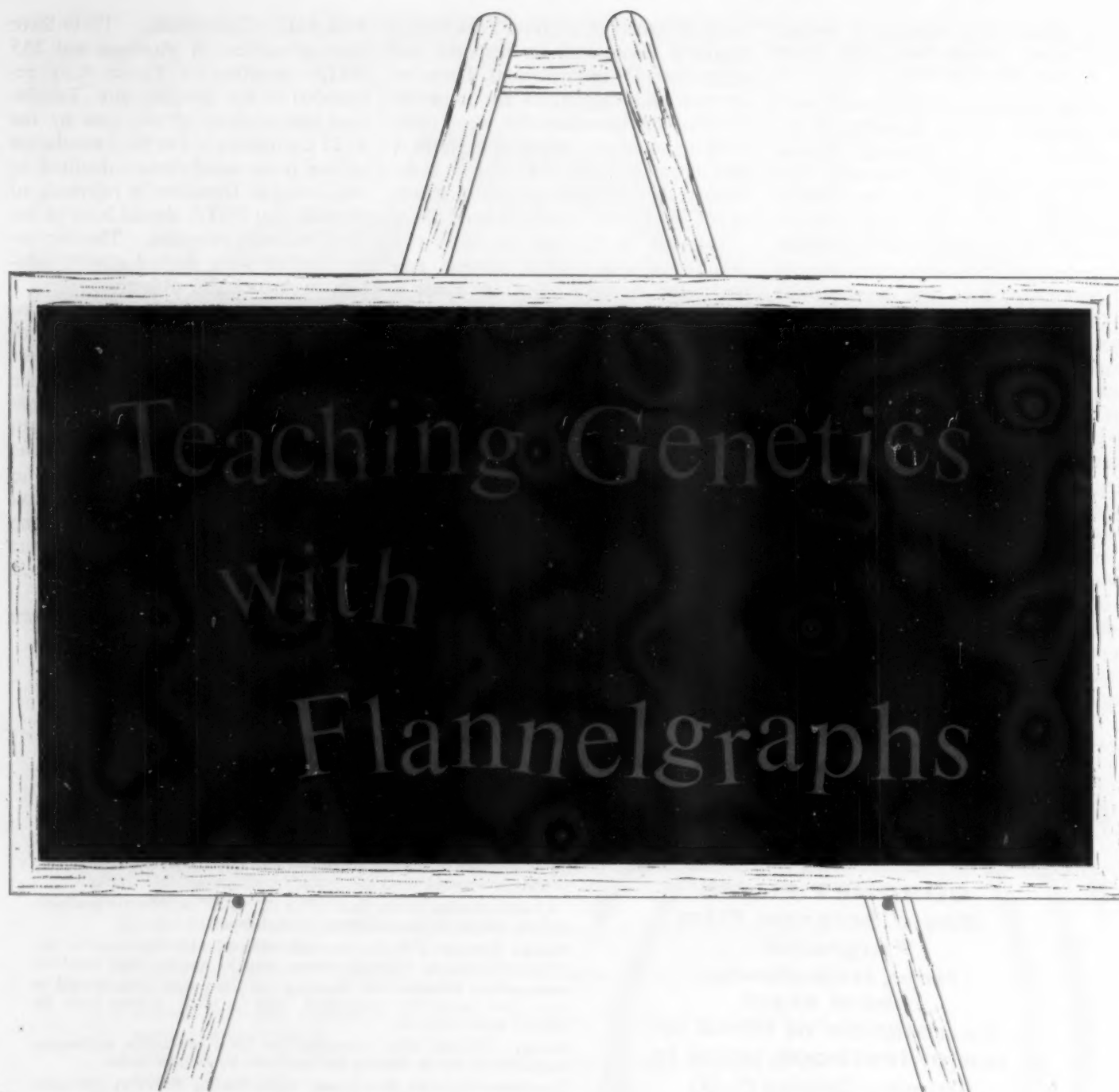
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FLANNELGRAPHS are familiar to most teachers, but comparatively few have used them. From my experience they represent one of the best visuals for teaching genetics, especially when constructed to correlate with texts and movies. Over a period of four years I have developed and used a comprehensive set of flannelgraphs for teaching the fundamentals of genetics. The rewards in attention getting, student interest and enthusiasm, and learning have been worth while.

If I told you I had a motion picture on any phase of genetics which you

could manipulate at will, you would all be satisfied; if you knew you could set the pace exactly as you wanted it; stop it effectively at any given point; progress to another point and stop to elaborate; repeat any given sequence with a press of a button and keep on display before the students at all times all the ideas which had been presented; furthermore, one which would allow all

pupils to "think aloud" simultaneously and silently; and, finally, that you could use it to test comprehension; you would all stampede to obtain a copy. Naturally I do not have a movie such as described, but by use of the same symbols used in movies on genetics, prepared as flannelgraphs these objectives are readily obtainable. By the use of these symbols I provide the animation

By MERLE I. WIMMER

Science Teacher, Thomas Carr Howe High School, Indianapolis, Indiana

and progressive development of ideas to accomplish these objectives. It does provide some extra work for the teacher, but the end results compensate for the time and extra effort.

Preparation

Preparation of any flannelgraph should follow the construction or purchase of a flannelboard. By doing this the units and sequences can be made in the proper proportion to the board. I have found two boards (3' x 4') hinged together to be adequate.

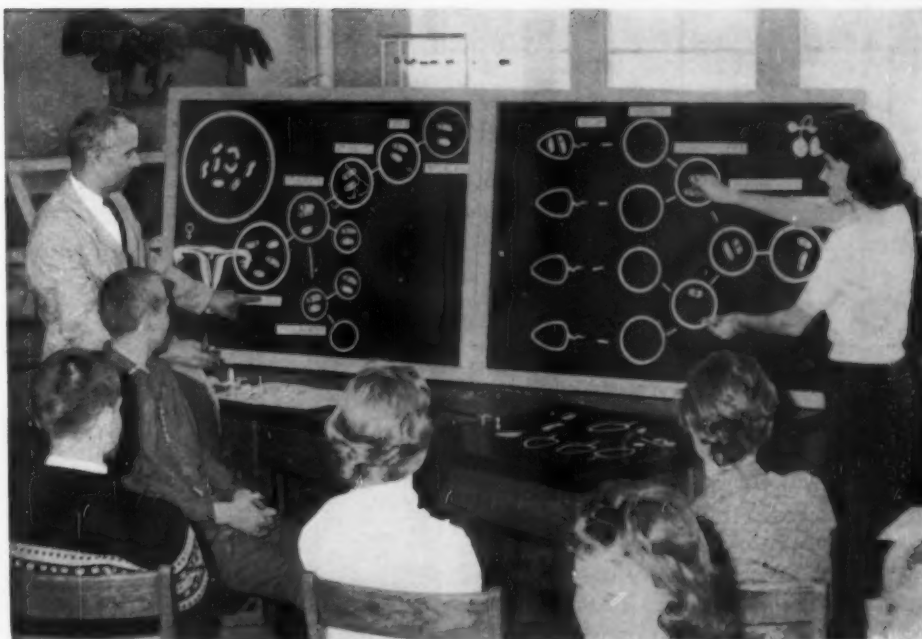
The materials needed for flannelgraphs are: (1) a high quality suede-backed paper; (2) luminous paint; and (3) a brush and scissors.

Select the sequence which you want to develop. Observe symbols used in texts and movies. Select these symbols and adapt them to the things you can do with paper. Most of them can be used without modification. Simply determine the size you need for the board. Remember that a sequence clearly gives a short story of a basic idea. Normally each symbol should represent only one thing in order that the sequence can be developed on the flannelboard step by step and prevent misunderstandings.

Prepare designs on ordinary cardboard and trace around them on flannelgraph paper which has been painted with luminous paint. The luminous paint provides better visibility of small symbols. Cut out the designs and test them on the board.

To date, I have prepared about twenty sequences representing the basic principles of genetics. Some of these are: (1) maturation of germ cells; (2) sex determination; (3) hybridization; (4) dominance and recessiveness; (5) incomplete dominance; (6) albinism in plants; and (7) albinism in animals. Sequences can be prepared for any principle that is desired.

For the maturation sequence, as an example, you will need about four, 6-inch open circles and one slightly larger for the egg cell membranes, and four, 4-inch ones for the polar bodies. In addition you will need about fifty chromosomes with at least two different colors and two lengths. The longer ones can be about 2½ inches. On a few of these use a printing pen to make a broad mark lengthwise through the middle. These serve for diads and tetrads in the primary egg cell and first



Student cooperation is increased by this method.

polar body. In my set I also have a cut-out of both male and female mammal reproductive organs, which can be used as a starting point for the germ cell maturation sequences.

For the sperm cell you will also need a number of five-inch circles painted a different color and at least five sperms with tapering heads about five by four inches at the widest point. A two-inch wavy tail will suffice for these.

Other sequences can be developed in the same manner by using symbols

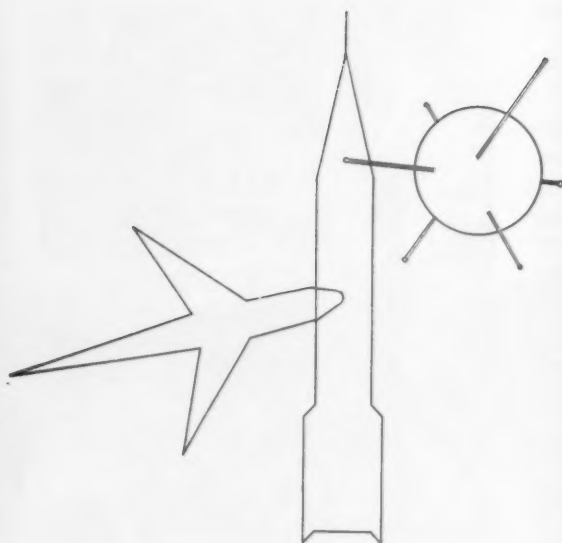
found in genetics books. In many cases you may wish to design your own symbols or expand a sequence.

For use in solving all problems of line and cross breeding, cut checkerboards from a full sheet of flannelgraph paper (11" x 14"). The cross bars should be about one-half inch wide to provide plenty of contact area with the flannelboard.

After the symbols have been completed, it is a simple matter to place them on the flannelboard in different

Students use flannelgraph units to illustrate reports.





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Laboratory sessions follow demonstrations. Assignments in packets lead students on to more difficult problems. In addition, problem solving leads to a two-way communication between student and teacher.

combinations and make color slides. Some which I have made include the maturation sequence, problems posed with Punnett squares, problems solved on Punnett squares, testing slides, etc. In addition to this I have made a three-minute color motion picture demonstrating only the maturation sequence. These provide for a quick review of all principles which have been studied.

Utilization

Use of the flannelgraphs will improve with experience. First, pose the problem. This may be printed on strips of flannelgraph paper and placed on the board, or written on the blackboard.

To develop the maturation sequence, place the cutout of the uterus with ovaries on the lower left. Place the larger circle over the ovary, to serve as a constant reminder as to where this event is taking place. Place at random at least four chromosomes representing two pairs inside this circle. This is the diploid number as in any body cell. The problem then is to show how and why reduction of chromosomes occurs. Place two pairs of the marked chromosomes with pairs adjacent, in the second ring which has been placed above and to the right of the first ring. Place two identical pairs in the same manner in the smaller ring representing the first polar body. Consult a maturation diagram in a textbook for placement of all

symbols. Fill the other rings with appropriate chromosomes. I always run the female sequence horizontally from left to right and the male sequence on the other board from right to left so the mature egg and sperm with the haploid number of chromosomes will be near each other when completed. When completed move one sperm to contact the egg cell membrane and move the chromosomes into the mature egg thus restoring the chromosomes to the original diploid number. A specific pair of genes can be marked on the chromosomes. The student can watch the progress of these genes at all times as maturation occurs.

To show possible combinations and results on the Punnett square, first use the complete sperms and eggs in the marginal spaces. Thus, the students will realize what the gametes really are. After this has been established substitute appropriate cutout letters for the special genes in the chromosomes and remove the egg and sperm cell membranes. From this point the students should be able to work, with understanding, problems either on paper, blackboard, or flannelboard by use of letters. Keeping the maturation sequence on display, occasionally test student comprehension of the origin of gametes by retracing the steps in gamete formation.

During the development of the entire

sequence be sure to allow students to ask questions. This is made easier for them by the fact that the symbols are all on display. Go back and review as needed and supplement by use of other available devices. On the blackboard, show students how they can diagram in their notebooks what you have placed on the flannelboard.

After demonstrations have been given with all sequences, an interesting and constructive laboratory session can be conducted. By use of the symbols the students can work on the tables first, the same problems demonstrated and then many others. The symbols for each sequence should be placed in a sturdy envelope which has been marked on the outside to indicate the genetic principle involved. An assignment sheet inside gives all problems to be worked. They can rotate the packets until each has solved all problems and entered the answers in their notebooks.

Testing

Part of the testing has really begun when you have your laboratory session. The students are placed on their own to apply what you have taught them by working additional problems. From any vantage point in the room you can see any mistake a student has made. In effect, by displaying the symbols the students are all "thinking aloud" silently, at one time and you are able to check their comprehension quickly by their performance.

A second way to test is to place all the cell membranes in proper position and some Punnett squares on the flannelboard. Place numbers in all spaces and ask students to substitute answers for the numbers, by recording the correct symbols or letters on a sheet of paper. For the Punnett squares, problems can be posed above as you would on a blackboard.

A third method is to prepare ditto masters showing only the framework of all sequences which have been demonstrated, as well as many other problems.

Thus far in a period of four years students have placed much higher on a test of 150 points than when conventional methods have been used.

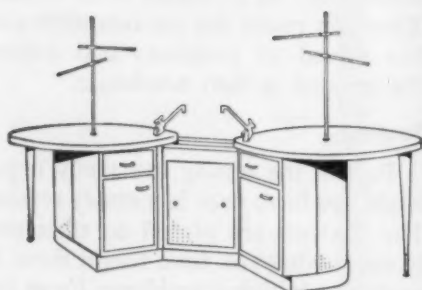
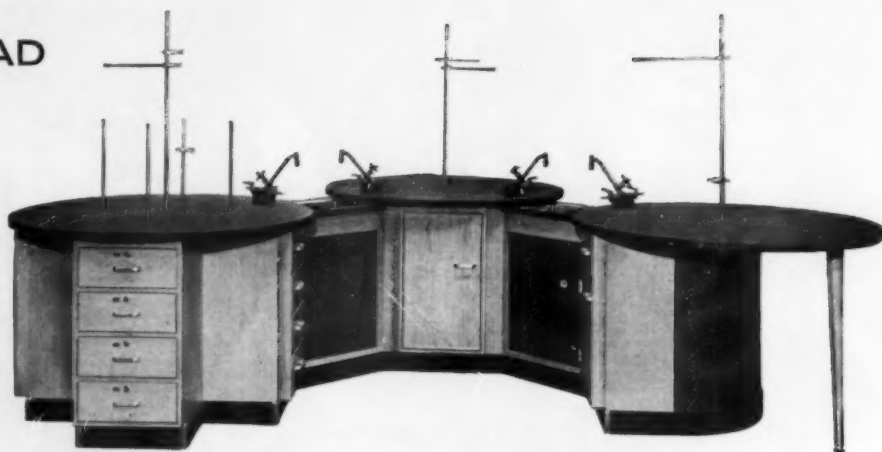
Summary

By using these flannelgraphs a better job of teaching genetics can be done in my opinion than with other devices. It is generally more profitable to use

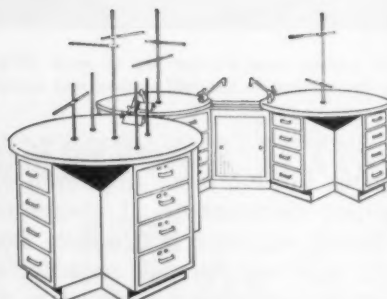
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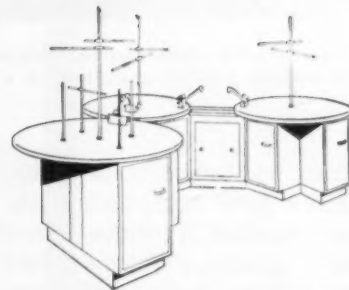
"Science Circle" Laboratory Furniture uses round tops, a choice of several storage bases, and interconnecting sinks to provide maximum work area at reasonable cost. Three types of base units are shown in this composite photo.



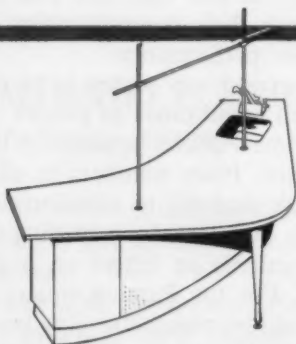
This eight-student arrangement for biology-physics-general science consists of two four-student tables with one interconnecting sink. Each table has two No. 821-P base units and a standard leg unit.



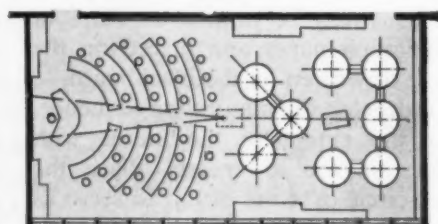
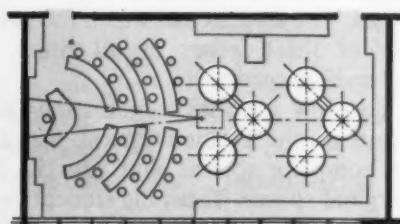
Twelve students can use this chemistry-physics arrangement of three tables in triangular arrangement. Each table has four No. 822-P base units. The two sinks each have two cold water faucets, four gas cocks, and four duplex electrical outlets. These services are standard.



This arrangement is similar to the preceding twelve-student combination but uses three No. 692 "Station Issue" base units with two sinks. Services are standard as noted before. Ring rods shown on all illustrations are optional equipment.

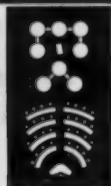


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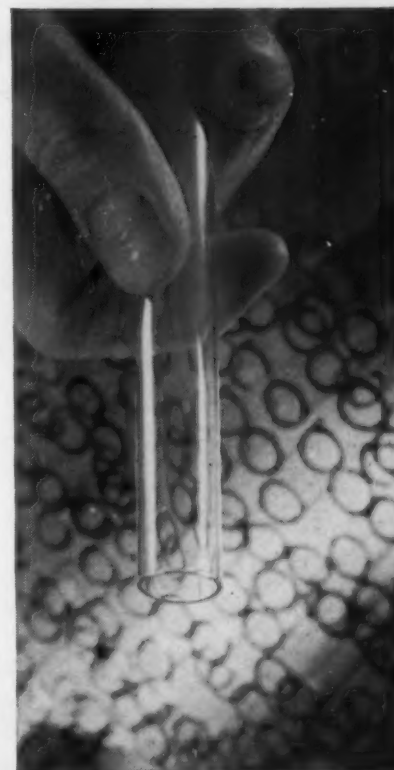
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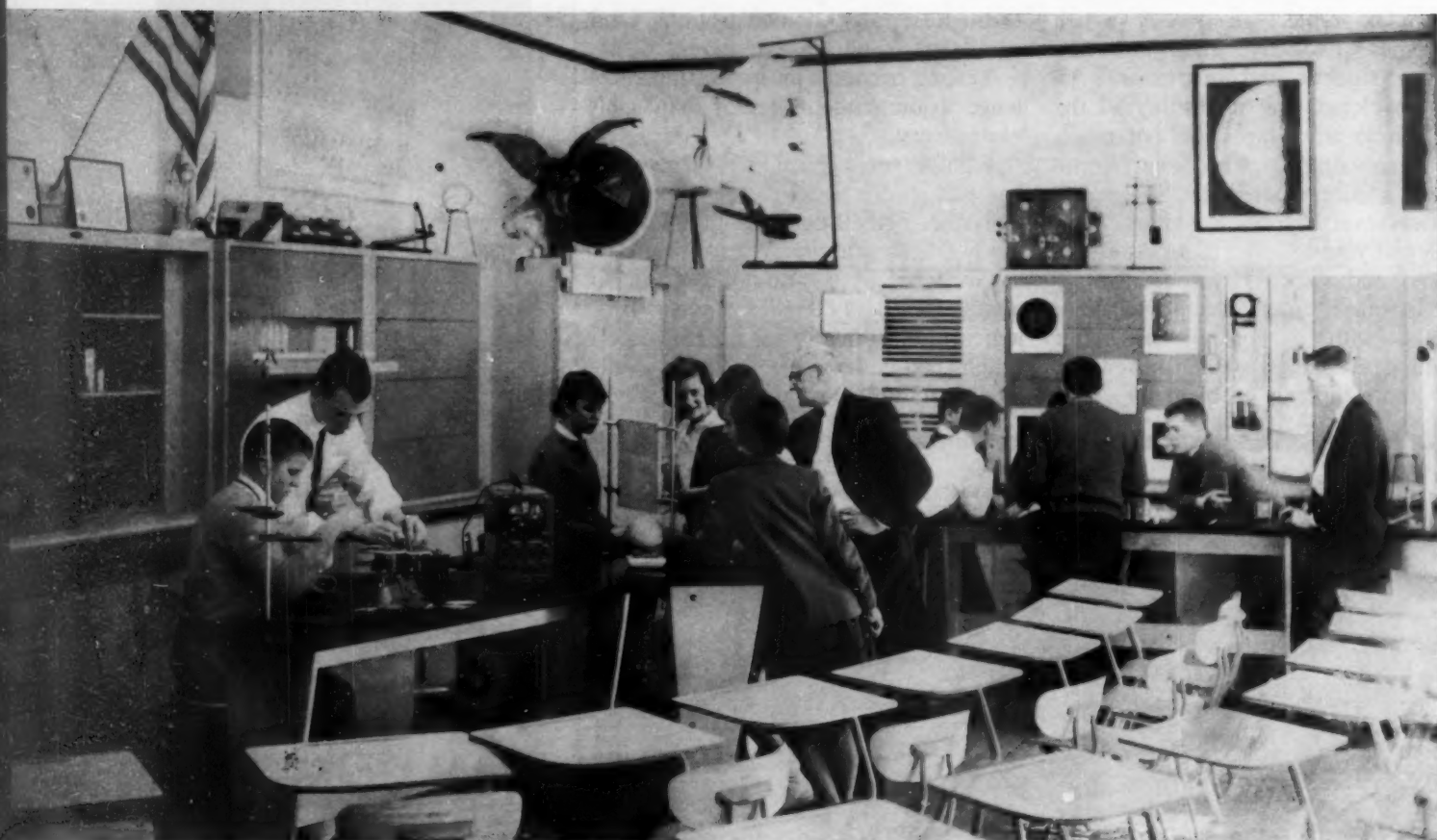
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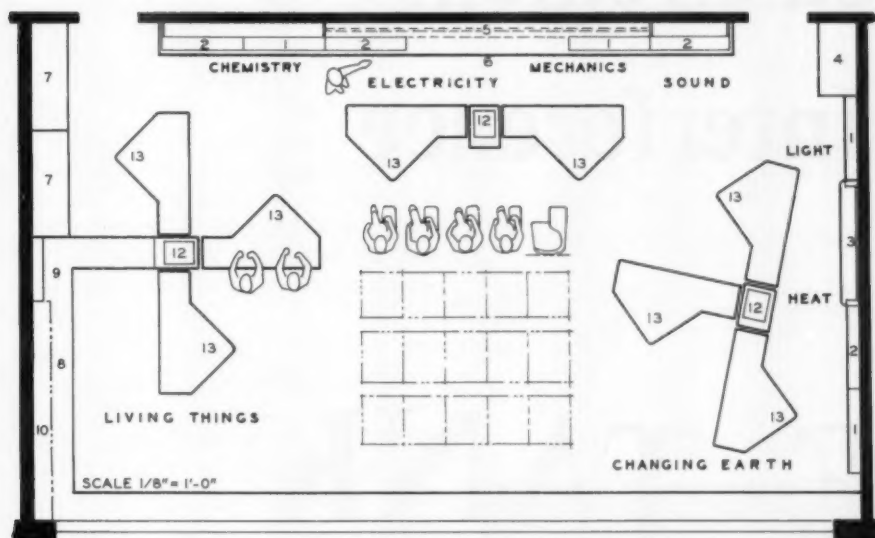
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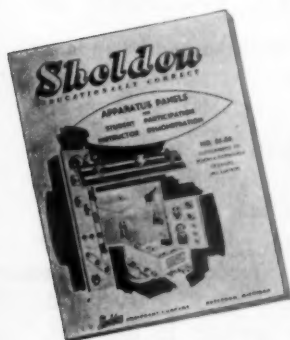


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Distance Measurement by Wave Interference in a RIPPLE TANK

RIPPLE tanks have been used in the past to demonstrate interference patterns of transverse waves. Usually the experiments have involved the interference pattern generated by two-point sources, or the effect of various barrier shapes on a straight wave. Most of the experiments to date illustrate two-dimensional patterns, that is to say, interference in a plane so that the explanation of the observed phenomena is related to the solution of a plane geometry problem.

Standing Waves

A simple arrangement has been devised to illustrate the interference between two straight wave trains. The advantage of this arrangement is that the formation of standing waves may be explained, and that the application of wave interference to measurement of distances may be illustrated. The principle of the experiment is analogous to that of the optical interferometer.

By **MARTIN ANNIS, JOHN WALTERS, and EDWIN C. WILLIAMS, JR.**

American Science and Engineering, Incorporated, Cambridge, Massachusetts

When two sources of straight waves of the same frequency face each other, a system of standing waves is set up composed of alternate regions of constructive and destructive interference. In the constructive regions, maximum displacement occurs; in the destructive regions or nodes, there is zero disturbance. Measurement of distance by interference is based on the fact that if one source is moved relative to the other source, a shift in the standing wave pattern takes place. The entire pattern shifts in the same direction as the source moves.

In order to perform an experiment illustrating the interference between two plane waves, it is necessary to have two straight wave generators operating at the same frequency. In principle, it

is possible to adjust one of two independent straight wave generators so that it operates at exactly the same frequency as the other generator. In order to do this, the frequency of one generator is varied until a stationary standing wave pattern appears in the tank. The existence of these standing waves indicates that the two generators are operating at the same frequency. It is also necessary that it be possible to move one of the two straight wave generators, when needed.

The apparatus we have developed consists of two "slave" ripple bar drivers facing each other and run off the same "master" continuous rotary switch. The "master" switch emits two electrical signals of the same frequency and of any desired phase relationship.

In the present experiment, the two signals are placed in phase. The arrangement ensures that the two ripple sources are locked to the same frequency. The "slave" systems are based on the attraction between a permanent magnet and a small solenoid. Figure 1 shows the setup in operation with the standing wave pattern evident. The distance between successive bright "fringes" (maximum up and down disturbance) is one-half wave length.

Figure 2(a) is a close-up showing two fixed markers defining the initial positions of two successive fringes. A third marker is placed at the shadow of the front edge of the right hand ripple bar. We are actually looking at the projected shadows of both the disturbances and the ripple bar.

Figure 2(b) shows a situation after the right-hand source has been moved a short distance toward the left-hand source. Figure 2(c) shows a situation after the source has been moved until the fringes have shifted one complete space. Notice that the source has moved twice as far as the fringe. In general, by counting the number of fringes which pass any fixed marker as the source is moved, we can calculate the distance the source has moved. Specifically, if the number of fringes which pass a fixed point is n , then the source has moved n times the wave length of the traveling waves.

The easiest way to explain the shift qualitatively is to point out that if two rippers are set in motion, locked in as to both frequency and phase (up at same time, down at same time), then there will always be a region of maximum disturbance halfway between them, since crests (or troughs) sent out at the same time will reach the halfway mark at the same time. This means that as one rippler is pushed toward the other, the central region will shift also, and its shift will always be one-half the displacement of the rippler. This can be shown more graphically by marking off 20 cm, say, and showing that the halfway mark is 10 cm. If the distance is then made 19 cm, the halfway mark is now 9.5 cm. A one-cm change in total distance has resulted in a 0.5-cm shift in the center point.

If a more rigorous approach to the problem is desired, it can be made via the equation for displacement of a medium at a distance, x , from a straight bar generator producing simple har-

monic waves. If D is the water displacement due to a traveling straight wave¹ produced by a single rippler bar, then:

$$D = A \sin 2\pi f \left(t - \frac{x}{v} \right),$$

where

- A is the amplitude of the displacement,
- f is the frequency of oscillation from the straight bar,
- t is the time measured from a selected zero time,
- x is the distance from the bar, and
- v is the velocity of the wave (i.e., the velocity of, say, a trough along the surface of the water).

The wave length, λ , of this wave that

¹ Traveling waves in water are not sine waves. To a good approximation, however, the phenomenon may be analyzed assuming the shape of the water wave to be that of a sine wave.

is the distance between successive peaks is defined as:

$$\lambda = \frac{v}{f}$$

When two identical generators are facing each other at a distance, L , as shown in Figure 3, the total displacement at a point, P , can be written as the sum of two displacements, D_1 and D_2 . D_1 , the displacement due to the left-hand bar, is:

$$D_1 = A \sin 2\pi f \left(t - \frac{x}{v} \right).$$

If the right-hand bar is moving with the same amplitude and frequency, then the displacement due to it is:

$$D_2 = A \sin 2\pi f \left(t - \frac{L - x}{v} \right).$$

The resultant displacement at any point, x , is the sum of D_1 and D_2 .

FIGURE 1. General view of apparatus.





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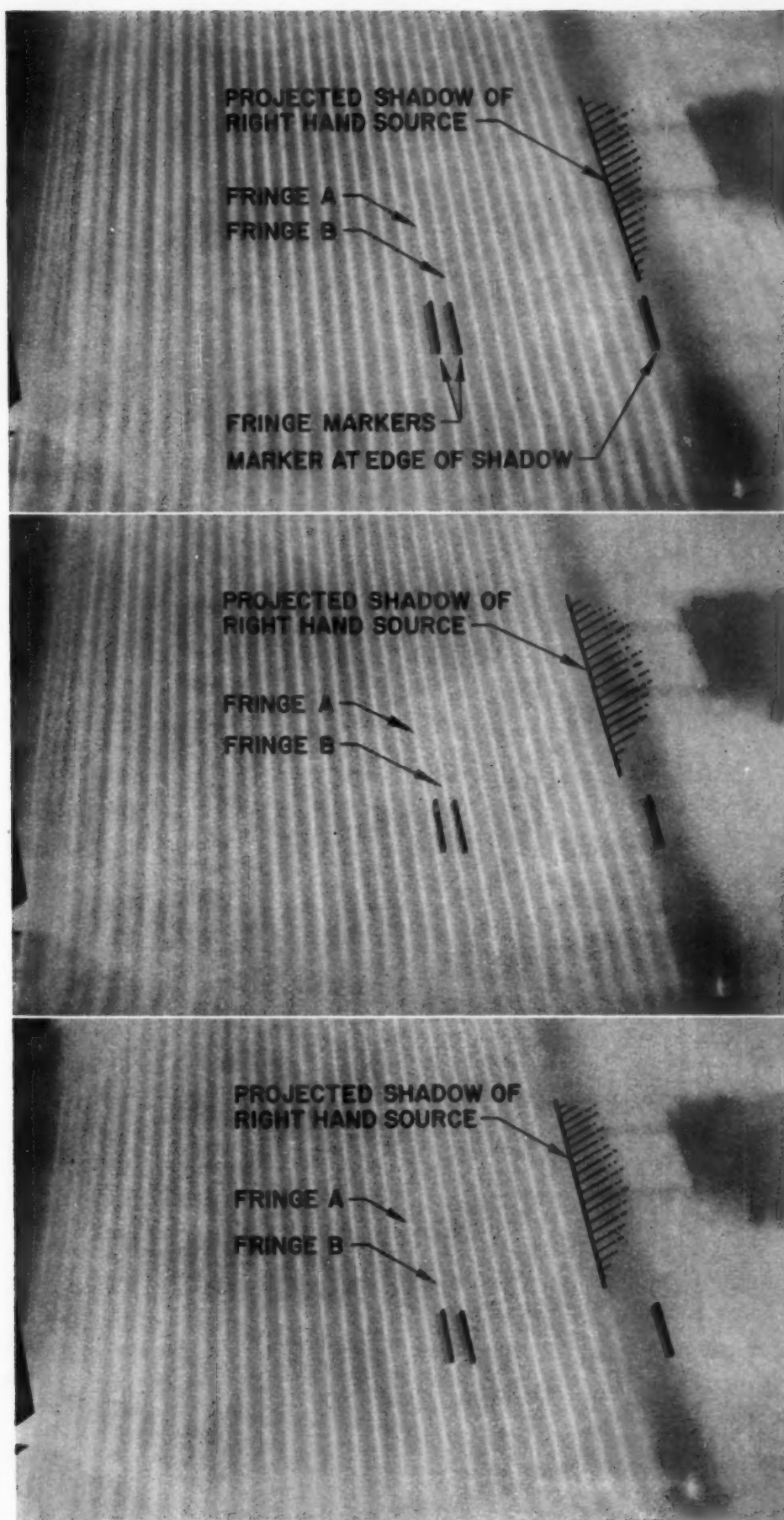


FIGURE 2. Sequence of pictures (a, b, and c) illustrating motion of fringes with respect to fixed markers as right-hand source is moved toward the left-hand source shows the displacement caused.

Thus:

$$D_1 + D_2 = A \sin 2\pi f \left(t - \frac{x}{v} \right) + A \sin 2\pi f \left(t - \frac{L-x}{v} \right).$$

By identities with which the secondary school trigonometry student is acquainted, the right-hand side of the last equation can be written as:

Displacement,

$$D_1 + D_2 = A \sin 2\pi f \left(t - \frac{L}{2v} \right) \cdot \cos 2\pi f \left(-\frac{x}{v} + \frac{L}{2v} \right).$$

This is the expression for standing waves. That is to say, for particular values of x , this expression indicates zero displacement, *i.e.*, nodes. Students

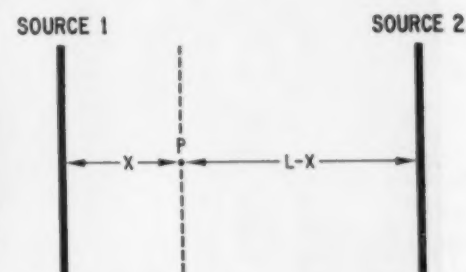


FIGURE 3. Diagram illustrating definition of terms.

can be encouraged to notice that the condition for nodes to exist is that the right-hand side be zero for all values of the time, t . This condition exists when

$$\cos 2\pi f \left(-\frac{x}{v} + \frac{L}{2v} \right)$$

is equal to zero. It can be shown that

$$\cos 2\pi f \left(-\frac{x}{v} + \frac{L}{2v} \right) = 0,$$

when

$$\frac{L}{2} - x = \frac{\lambda}{4}, \frac{3\lambda}{4}, \frac{5\lambda}{4}, \text{ etc.,}$$

where λ , the wave length, is

$$\frac{v}{f}.$$

The effect of relative phase on the interference pattern may also be demonstrated if, as is true for the equipment shown in Figure 1, the phase of one of the straight wave generators may be changed with respect to the other. Thus, as the phase of, say, the left-hand source is shifted by 360° with respect to the right-hand source by utilizing the "master" switch, then the fringe pattern is observed to shift by exactly one-half wave length (the distance between two adjacent fringes).

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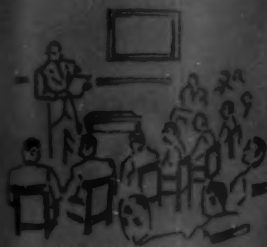
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Seminar on the Disciplines

By **RICHARD I. MILLER**

Associate Director, Project on Instruction Program of the Public Schools, National Education Association, Washington, D. C.

TODAY American education is focusing on the nature of knowledge and ways of knowing to an extent unprecedented in our history. Although important work has preceded today's surge of interest and development,¹ at least three factors have added a sense of urgency nonexistent in the past:

1. The so-called "explosion of knowledge" is nothing new. Certainly it was of concern to educators at the turn of the twentieth century, but the differences today reside in the accelerating rate of change and the increasing complexity of knowledge itself. For example, compare the automobile in the early 1900's with today's model. Joseph J. Schwab, University of Chicago, Illinois, and J. Robert Oppenheimer of the Institute for Advanced Study at Princeton, New Jersey, have both estimated that the revisionary cycle for science now is about every fifteen years.

2. The demand for quality education has been part of the great reappraisal in American education, which started shortly after the end of the Second World War and has since increased in depth and scope.

3. The cold war has accentuated, sharpened, and added a sense of urgency to this reappraisal—not only in education but in all walks of life.

It is in this setting that the National Education Association Project on In-

struction sponsored the Disciplines Seminar on June 15-17, 1961, at Washington, D. C. Over 90 distinguished scholars in various disciplines, scholars in education, and teachers examined the fundamental ideas and/or methods of inquiry from selected fields of study that should be in the mainstream of the instructional program of the public schools, and explored frontier thinking and research in the nature of knowledge and ways of knowing.

In addition to two general presentations on learning knowledge and ways of knowing, included were those in Art, English, Language, Music, Philosophy and Religion, Biology, Chemistry, Mathematics, Physics, Anthropology, Communications, Economics, Geography, History, Political Science, and Psychology. A brief summary of the reports on biology, chemistry, mathematics, and physics follows:²

Dr. Joseph J. Schwab made seven recommendations for a biology program in the elementary or secondary school as follows:

1. That students learn about the development, health, and disease of their own bodies, not only for the sake of their comfort and the best use of those bodies but also to quiet the anxieties growing out of ignorance of the facts of growth and development;

2. That genetics and evolution be taught because of its contribution to an understanding of man in relation to all other organisms and in relation to the world, and because of what it has to say about class and kind;

3. That a substantial amount of ecology be taught for knowledge of the interrelations of plants, animals, and men to one another and to their environment and because of its relevance to political and economic problems;

4. That a touch of biochemistry be taught because of its contribution to a view of the perennial connection between life and non-life;

5. That a touch, also, of biopsychology be taught to give students some idea of the world of competing authorities, and especially in this instance, to balance viewpoints which see all behavior as environmentally determined;

6. That something of old-fashioned, systematic zoology and biology be taught, primarily to indicate how useful, but how arbitrary, questionable, and merely convenient, it is to place all things into systems;

7. Finally, that each of the foregoing be taught within the framework, the narrative, of the inquiry which produced it.

Dr. Alfred B. Garrett, Chairman of the Department of Chemistry, The Ohio State University, Columbus, said science can and should serve these purposes: (1) To interpret the universe; (2) To provide awareness of the dynamic, continually evolving character of scientific knowledge; (3) To be aware of the impact of scientific developments upon other areas; (4) To

¹ John Dewey, Charles Judd, Boyd Bode, William Brownell, Jean Piaget, Barbel Inhelder, and Jerome Bruner have made notable contributions in this area.

² These summaries are drawn from a report of the Disciplines Seminar prepared by Mrs. Dorsey Baynham, Educational Writer (Washington, D. C.) for the Project on Instruction.

instill the habit of challenging hypotheses in any area of life; and (5) To provide some understanding of the creative process through the historical approach by use of simple case studies.

Turning to his field, chemistry, Dr. Garrett suggested two specific goals. The study of chemistry, he said should provide knowledge of both the organic and the inorganic world. It should outline the evolutionary processes (chemical, physical, and nuclear) that have progressively altered the world over the several million years of its existence.

This includes not only terrestrial but also astrochemistry.

These objectives are a large order, and certainly an exciting one. But with the simple fundamental principles that can be taught in a first course in chemistry, students by the end of the course should be able to predict what is happening in the star at the farthest edge of the universe.

Dr. G. Baley Price, Executive Secretary of the Conference Board of the Mathematical Sciences of the American Association for the Advancement

of Science, outlined for the Seminar two guiding principles. The first says that students can learn an abstract subject like mathematics at a very early age. This fact has been demonstrated in programs which taught the most basic geometry to first-grade students and by another program which taught certain fundamentals of symbolic logic to fourth- and fifth-grade students. The major significance of this principle is that it allows extreme flexibility. Mathematics curriculum, apparently, can be constructed on many other bases than simply student age.

The second guiding principle is to the effect that American mathematicians have not abandoned the classic goal of providing a general education for the great mass of students, despite some belief to the contrary. New and different mathematics subjects are, indeed, showing up in school programs but, according to Dr. Price, they are being introduced in accordance with the concept of providing a general education, designed to equip students for modern life. This means that: (1) In the welter of possible mathematics courses, it will be necessary to make choices; some topics will be discarded, others will be added; (2) It is necessary also to teach high school mathematics so that the students gain a far deeper understanding of the subject than they have in the past.

Few of this country's approximately 10,000 physics teachers have been prepared with a major in physics, according to Dr. Gilbert C. Finlay, Professor of Education at the University of Illinois, Urbana, who has been associated closely with the Physical Science Study Committee. Many of these teachers have had only a year or a little longer of college physics courses. Indeed, many of them have been converted from teaching other subjects and even in the day-by-day training gained through teaching itself, they have been limited to the physics available in textbooks, films, and laboratory materials. Furthermore, the demand for graduates with a major in physics in other, higher-paying fields than teaching will probably hold the teacher supply to what it is for the foreseeable future.

The competition has resulted also in limiting the number to a relatively few who are in a position to give leadership to the development of new programs and who are actively interested in the teaching of physics. But into this



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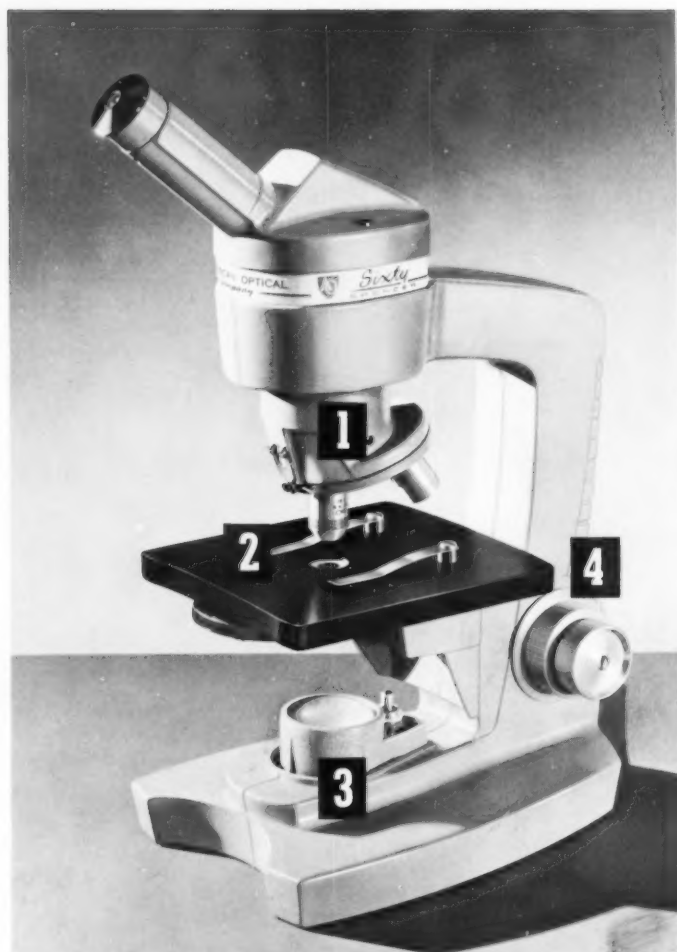
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leadership void has stepped a group of physicists who, working with high school teachers, have set themselves the task of formulating a structure of physics that would be manageable within a year and that would concentrate on the unifying ideas and type of inquiry that led to those ideas.

Some scientists believe that science teaching has been characterized by an anti-scientific approach. Ideas have been presented as assertions and demonstrated by illustrative application. The choice of ideas, in itself, has been open to question, particularly in light of recent scientific development.

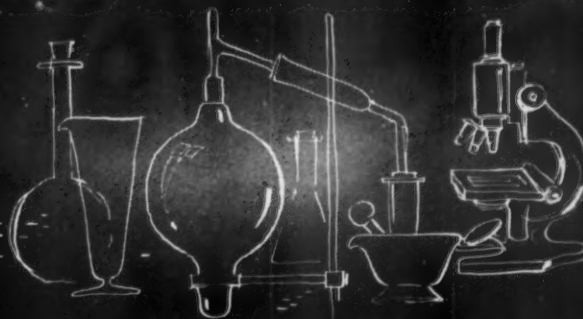
The new approach, consistent with the viewpoint of contemporary physicists, stresses the idea that scientific conclusions are tentative, often fallible; new materials, ranging from textbooks to films and laboratory equipment, emphasize the *argument* that leads to fundamental ideas.

Finding ways to make laboratory work fit the investigative requirements of the field, rather than to be used merely to confirm already stated ideas, has been a particular concern of the physics projects. The laboratory, it is believed, should be a primary learning resource to which textbook, film, and lecture are subordinate.

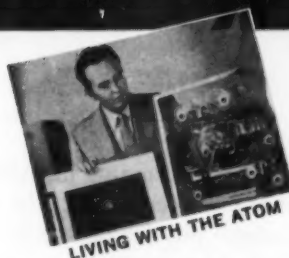
The Chairman of the Seminar, Dr. Ralph W. Tyler, Director of the Center for Advanced Study in the Behavioral Sciences, Stanford, California, opened the Seminar with this explanation of the expectations hoped for: "It is not to answer . . . in detail what are these things to be taught, but more generally to get a correlation about what kinds of things are to be taught, what is the nature of these fields, and what are we to look for as new instructional materials come out, new texts, new teacher guides. . . . We are interested in getting ideas on the record and in having these ideas examined and criticized where members feel they should be criticized as a basis for guidelines, to help teachers and schools in the better development of their educational programs."

And Dr. George Gerbner, Professor of Communications at the University of Illinois, Urbana, closed the Seminar with this observation: "The faults and failures we have noted in teaching and teachers are, to a large extent, the faults and failures of the disciplines, themselves."

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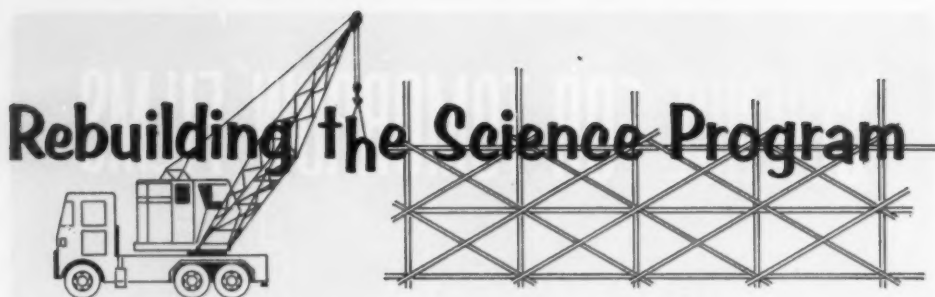
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Physics

Study of High School Physics Achievement

By WARREN L. HIPSHER

Assistant Professor of Education, The University of Tulsa, Tulsa, Oklahoma

THIS investigation¹ was made in Will Rogers High School, Tulsa, Oklahoma during the school years 1957-58 and 1958-59. It was designed to compare the relative effectiveness of the traditional high school physics cur-

riculum and the physics curriculum developed by the Physical Science Study Committee.²

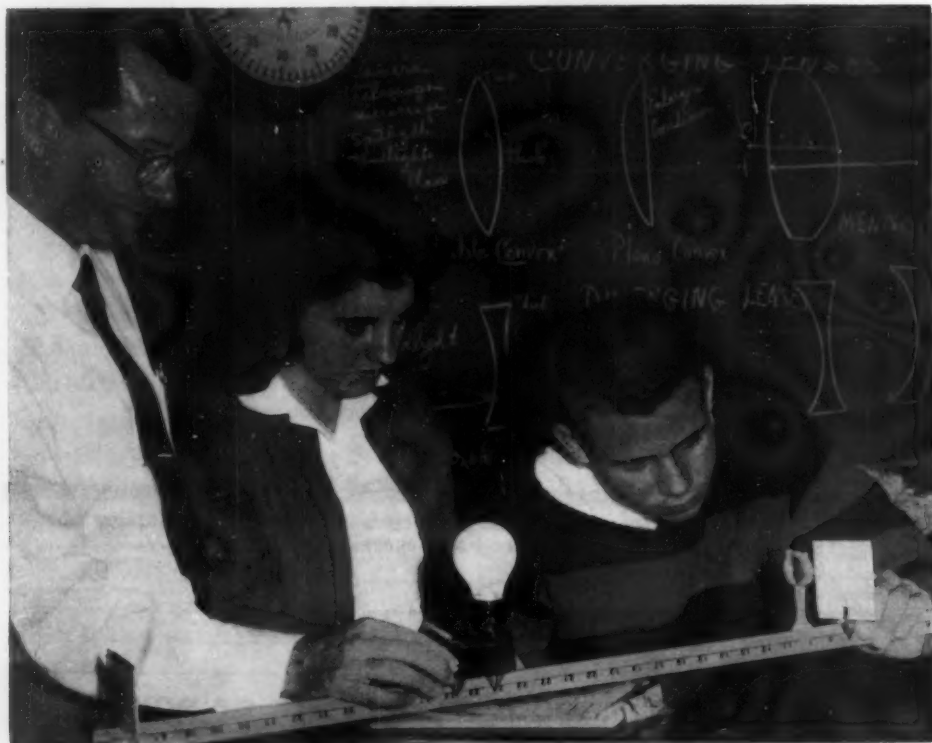
The population sample included 208 male seniors, who completed the course in high school physics during this two-year period. Ninety-nine male students

¹ This investigation was completed under the direction of Marlow A. Markert in partial fulfillment of the Doctor's Degree in Education at the University of Tulsa, Tulsa, Oklahoma. June 1960.

² *First Annual Report of the Physical Science Study Committee*. The Committee, 164 Main Street, Watertown 72, Massachusetts. 1958.

The teacher, Harold B. McCord (left), instructs two students in the experimental group.

JULIE HUNT, TULSA, OKLA.



were designated as the control group, for whom complete test data were available and who were taught high school physics at Will Rogers High School during the 1957-58 school year using the traditional physics curriculum. The experimental group included 109 male students for whom complete test data were available and who were taught high school physics at Will Rogers High School during the 1958-59 school year using the physics curriculum developed by the Physical Science Study Committee. Since the control group included only 12 female students and the experimental group included only 20 female students, a decision was made to delete the test data for all female students in the two groups so that individual differences due to sex would not effect the findings of the study. A comparison of the two curricula for females seemed impracticable. No female students were included in the statistical analysis made in this investigation.

The statistical technique utilized in this investigation was the analysis of covariance. The following hypothesis was tested: there is no difference in the mean achievement of the control and the experimental groups in their response to the criterion, the Cooperative Physics Test, when the variables of scholastic aptitude, prior achievement in natural science, physical science aptitude, and socio-economic status are statistically controlled. The analysis of covariance made it possible to determine if students taught using the experimental curriculum did significantly better on their response to the criterion than students taught by the use of the traditional curriculum. Simultaneously, this provided for the control of individual differences that influence or are thought to influence the achievement of the students in the two groups.

Final achievement in high school physics was measured by Form Z of the Cooperative Physics Test. Four variables were statistically controlled: scholastic aptitude, prior achievement in natural science, physical science aptitude, and socio-economic status. These variables were measured respectively by: the Gamma Form of the Otis Quick-Scoring Mental Ability Test, Form YZ of the General Achievement Test in Natural Science, the Engineering and Physical Science Aptitude Test, and the North Hatt Scale. Both groups were taught by the same teacher, in the

same classroom, for the same length of time, and in comparable sized classes. The one variable present in both situations, the effects of which were under consideration in this investigation, was the curriculum used to teach high school physics.

The null hypothesis was rejected. The observed differences, in Cooperative Physics Test scores between the control and the experimental groups with the independent variables held constant, were significant at the .01 level of confidence.

The criterion means were adjusted and the control group mean exceeded the experimental group mean by 9.5356. The 95 per cent confidence limits of the differences were 6.1618 and 12.9174. It was concluded that the control group mean probably exceeded that of the experimental group by at least 6 points which is equal to one-half the standard deviation of either group. Thus students, taught physics using the traditional high school physics curriculum, performed significantly better on the Cooperative Physics Test than students taught high school physics using the curriculum developed by the Physical Science Study Committee; *i.e.*, when scholastic aptitude, prior achievement in natural science, physical science aptitude, and socio-economic status are statistically controlled and the variables of the teacher, physical plant, class time, and class size are held constant for both groups in the study.

The criterion used in this study is acknowledged to be designed for the purpose of measuring achievement in physics when a traditional physics curriculum has been in use. The basic selection of the material for the Cooperative Physics Test was based upon syllabi of the College Board Entrance Examination Committee and the New York Board of Regents' Examination.³ Form Z, the latest revision of the Cooperative Physics Test is a traditionally oriented test. As a result of the choice of this particular criterion, the students in the control group may have had an advantage over the students in the experimental group. If such an advantage did exist because of the selection of this particular criterion, then the results of this investigation would be

³ Oscar K. Buros. *The Nineteen Forty Mental Measurements Yearbook*. Braunworth and Company, Inc., Bridgeport, Connecticut. 1941.



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The experimental group working over a two-year period included senior students of both sexes.

biased in favor of the control group to the extent that such an advantage existed between the two.

Most colleges and universities were and are oriented toward traditional physics in their introductory course in college physics. Thus the preparation of high school graduates to succeed in a traditional physics curriculum at the college level might be one of the expectations and requirements for any high school physics program.

The results of this study raise the question concerning the effectiveness of the Physical Science Study Commit-

tee curriculum in preparing students for traditionally oriented courses in college physics. The outcome of this study in Will Rogers High School suggests the desirability of local studies in other schools adopting the new curriculum.

If other studies obtain results similar to those of this investigation, the orientation of college physics departments to the objectives of the new course seems to be needed. Otherwise the program may fail, regardless of the virtues of the new program, because high school graduates may not meet the expectations of college physics teachers.

Test of Homogeneity of Means of Control and Experimental Groups

Source of Variation	Degrees of Freedom	Residuals	
		Sum of Squares	Mean Square
Total	203	19,605.8350	
Within subgroups	202	15,336.3417	75.9224
Difference	1	4,269.4933	4,269.4933

$$F_{1,202} = 56.2349$$

With 1 and 202 degrees of freedom $F_{(.01)} = 6.76$

$$F_0 > F_{(.01)}$$

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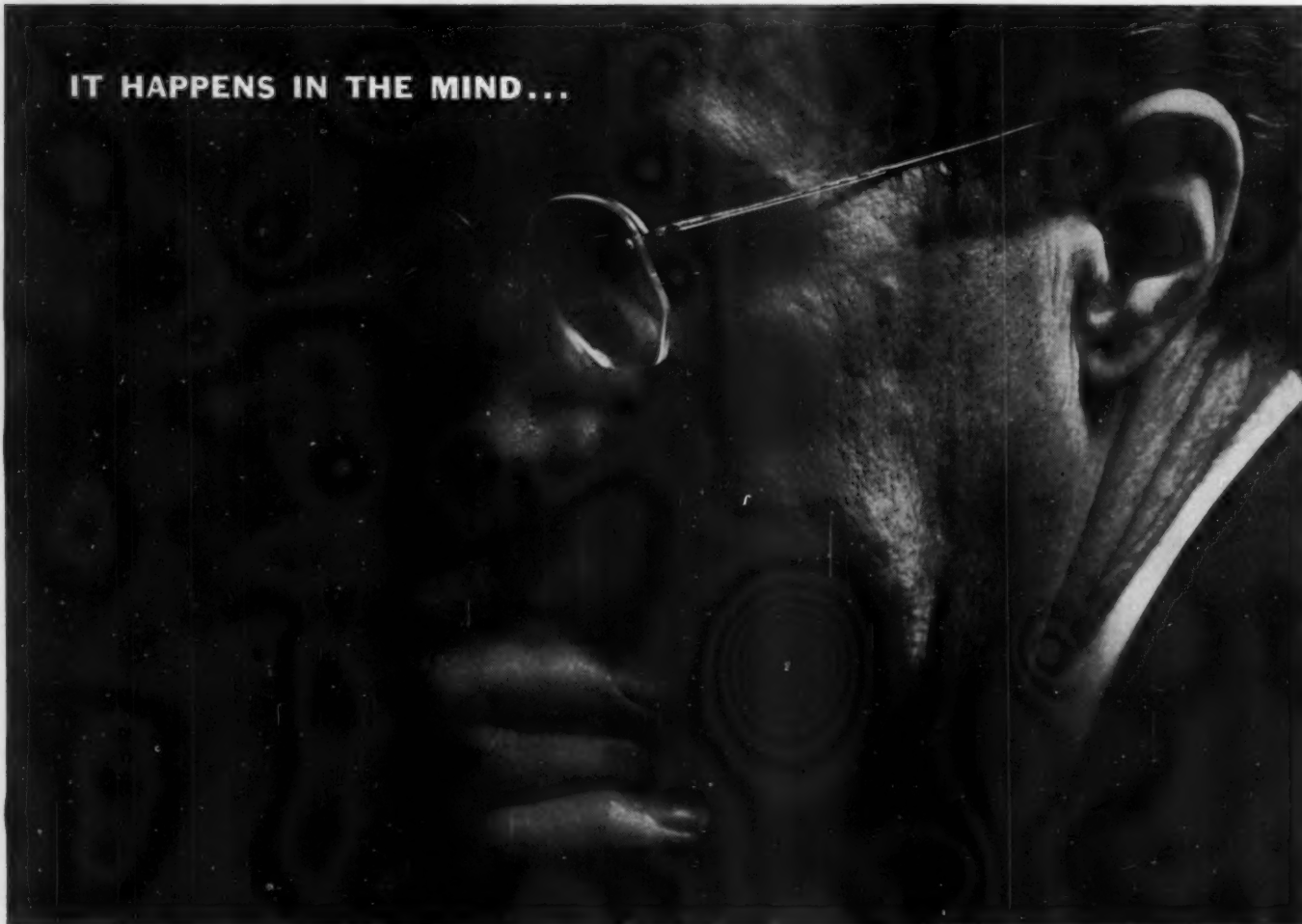
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General

Survey of the Science Supervisor

By PAUL F. PLOUTZ

Science Coordinator, Livonia Public Schools, Livonia, Michigan

THE purpose of this study was to determine the science supervisor's conditions of employment, status, and professional responsibilities.

Since the science-helping teacher, resource person, coordinator, consultant, or supervisor have a basic common similarity, that of assisting in the improvement of science education, use of the term science supervisor is loosely defined so as to include these other positions and titles commonly provided.

This study is based on results obtained from one hundred supervisors of science at four levels, elementary, K-12, secondary, and state. Elementary supervisors are interpreted as working with grades one through eight, K-12 as working from kindergarten through twelve, secondary supervisors as working with grades nine through twelve. State science supervisors are employed by a state commissioner and serve with a state department of public instruction in the school system.

Purpose and Procedure

Since the science supervisor is relatively new to public education, the role of the "typical" supervisor is vague and undefined. By defining this role and formulating recommendations for the science supervisor's part in the improvement of science education, this study can serve as a guide at all levels.

Defining the role of the science supervisor in specific terms will enable boards of education, administrators, superintendents, and principals to see how the science supervisor contributes to the improvement of science education. Those educators recognizing the need, but uncertain as to how to improve the science program, can be provided information necessary to employ a science supervisor, and outline con-

ditions of employment, authority, and major responsibilities to the supervisors employed from this survey.

In selecting supervisors and defining their role, the writer has increased reliability of data collected on the basis of numerous accepted research methods: (1) population based on select groups, (2) questionnaire specifically designed and prepared to poll supervisors of science, (3) supervisors polled at four levels, elementary, K-12, secondary, and state, (4) supervisors selected from thirty-two states with greater representation from regions of dense population, (5) supervisors selected from small school districts as well as large metropolitan systems, (6) many questions relative to function and status to provide for wide variation of response, (7) sampling and revision of research questionnaire by supervisors of science prior to distribution, (8) supervisors previously identified as to (a) part- or full-time, (b) grade level of employment, and (9) secured prior permission of supervisors to participate in study to encourage favorable attitude toward careful completion of responses.

Findings

Supervisors at *all* levels report spending the greatest amount of their time in: (descending order of frequency mentioned) (1) assisting teachers in the classroom, (2) providing materials, supplies, and information, (3) curriculum development, (4) organizing with department heads, principals, and superintendents, (5) providing in-service education, (6) teaching demonstration classes, and (7) administering the National Defense Education Act.

Questionnaire data revealed many similarities of conditions of employment, status, and responsibility, com-

mon to elementary, K-12, secondary, and state science supervisors. The following similarities were reported by the majority of supervisors at *each* of the four levels:

1. Receive operating funds as a part of the regular school budget.
2. Include materials, office, and equipment as a part of the administrative organization.
3. Plan and direct own activities freely.
4. Receive automatic salary advances from year to year.
5. Authorized to organize science workshops.
6. Organize science workshops, independently.
7. Work with groups of teachers.
8. Work with individual teachers.
9. Work with principals.
10. Meet on a five-day week schedule.
11. Employ part- or full-time secretarial assistance.
12. Encourage science teachers to join state and national organizations related to science.
13. Assist in details of equipment and design in the event of remodeling or construction of science classrooms.
14. Visit other school systems.
15. Attend state, regional, or national professional meetings.
16. Influence or advise in instructional methods in science teaching.
17. Involved in "public relations" functions.
18. Assist teachers in the selection of textbooks.
19. Set up objectives for science programs or individual courses.
20. Organize materials for instructional purposes.
21. Help determine evaluative methods to be employed in the classrooms.
22. Have "jurisdiction" over more than 1000 students.
23. Work with more than five schools.
24. Receive a salary above level of regular science teachers.
25. Belong to five or more professional organizations.
26. Require six or more years of formal college training.
27. Require one year of college above the Master of Arts or Master of Science Degree.
28. Require the Master's Degree from a college of education.
29. Require major or minor in either science or education, or both, at the Bachelor's Degree level.
30. Require major or minor in either

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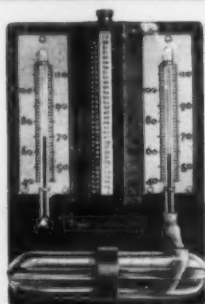


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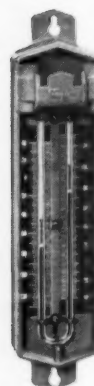


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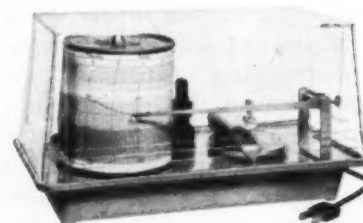
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Naturally, the science supervisor's role will be determined by the size and needs of the school as influenced by the objectives of the instructional program. Due to differing conditions within school systems throughout the United States, there is probably no such thing as "the model supervisor."

Supervisors report that they *should* but *are unable* to: (descending order of frequency reported)

1. Spend more time in the classroom assisting and *counseling* with teachers, and less time with administrative and non-teaching tasks.
2. Spend more time reading, preparing bulletins, newsletters, providing up-to-date sources of information for teachers, and *improving communication* between teachers as well as administrators and other personnel.
3. Provide more workshops, demonstrations, seminars, conferences, to improve the *in-service education* program for teachers.
4. Spend more time organizing techniques, teaching units, kits, audio-visual materials, into present or newly planned science curriculum.
5. Spend more time providing and preparing materials and equipment for *classroom instruction*.
6. Spend more time organizing and conducting educational or scientific *experimentation* and *research*.
7. Attend more state, regional, and national professional meetings to

learn of new equipment, techniques, trends, and *stay up-to-date*.

Supervisors reported that their greatest handicaps were (1) being involved in too many areas, and too many administrative duties, (2) having a lack of sufficient status or authority to properly effect change, (3) staying within a considerable amount of "line-of-authority" and "red tape" rules, (4) not being able to stay up-to-date or be proficient in all science areas, (5) dealing with poorly trained teachers and negative or indifferent attitude toward science by administrators, and (7) no clearly defined framework to operate in or function and duties vague.

Recommendations

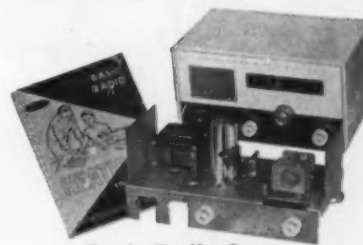
Recommendations given by present science supervisors to present and future elementary, K-12, secondary, and state supervisors for the *improvement of science education in the United States* are:

1. Develop good working conditions with teachers and administrators by being patient in effecting change, demonstrating leadership and not interference, and realizing that science is *one* of the areas of the instructional program.
2. Prepare yourself well, both in science content and education areas, to discuss intelligently, and to assist and demonstrate ability in all of the science areas.
3. Stay up-to-date by encouraging and being active in the local,

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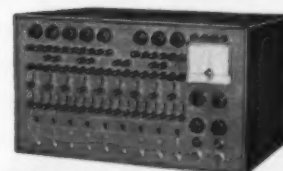
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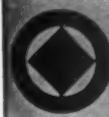
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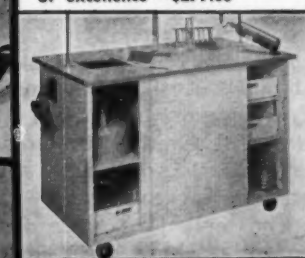
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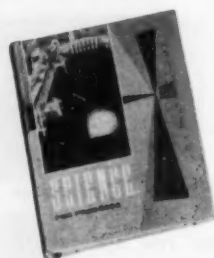
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6. Continually work for and maintain a continuous grade-to-grade science instructional program, each teacher aware of what others are doing, insisting on a "vertical" K-12 science sequence.
7. Strive for securing well-trained and enthusiastic teachers, and retain them by working for improved salaries, favorable teaching loads and facilities, and give encouragement and recognition.
8. Develop a sense of humor, have an understanding of the teacher's point of view by showing and helping rather than telling. Avoid "knowing it all," sell your point with enthusiasm, not authority.
9. Develop and maintain an active, workable in-service training program for teachers.
10. Work to "sell" science to principals, administrators, parents, civic groups, industry, and the general public.
11. Free yourself of excessive administrative and nonscience tasks to enable you to spend more time with classroom teachers.
12. Devote more time to providing and preparing materials and equipment for instructional purposes.
13. Spend more time organizing and conducting experimentation and research.
14. Work to be consulted in the recruitment, hiring, placement, orientation, training, and dismissal of science teaching personnel.
15. Prepare a regular bulletin, newsletter or similar device to increase communication between teaching, administrative, and supervisory personnel.
16. Spend more time evaluating texts, courses, programs, instruction, and organizing a testing program.

Further research, particularly in the area of elementary science, is recommended to discover ways in which the science instructional program can be enlarged and improved. The writer concludes that school systems wishing to improve their science program should consider employment of a science supervisor as soon as feasible.



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Earth Science—The World We Live In is indeed the proven leader among earth science texts. Last year alone over 50,000 copies were sold, and 1961 sales are surging upward. The text has been adopted exclusively in Florida and Indiana. A recent survey in still another state shows that, of the 514 schools offering earth science courses, over 400 use the *Namowitz and Stone text*. Be sure to see the new supplementary volume, *Activities in Earth Science*, by Namowitz, packed with real experiments and activities to be performed by the student rather than to be demonstrated by the teacher.



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Biology

Biology Laboratory Instruction Innovation

By ADDISON E. LEE

Director, Science Education Center, The University of Texas, Austin, Texas

IT has been said that elementary biology as commonly taught in high school and college today often consists of telling, not teaching; of recitations, not discussions; of memorizing, not reasoning; of words, not ideas; of watching laboratory demonstrations, not doing laboratory work; of copying answers, not interpreting observations and data.

These things have been said over the past 60 or 70 years at least—by individual teachers, by critics of teachers, and by committees. The problems have been clearly recognized for some time by scientists and teachers. They have been complicated by limitations of laboratory facilities and equipment, demands on the teacher's time, demands on the student's time, and sometimes a lack of knowledge and appreciation of the experimental approach characteristic of many biology teachers. The problems are further complicated today not only by the population explosion but by a likewise dramatic explosion of the nature and magnitude of our scientific knowledge. It seems apparent that the solution lies, in part at least, in the development of appropriate curriculum materials, the use of which will enable the teacher to overcome these difficulties or to succeed in spite of them.

The American Institute of Biological Sciences, with major support from the National Science Foundation, has undertaken the task of contributing to the improvement of biological education. One of the significant steps in this direction has been the organization of the Biological Sciences Curriculum Study (see *The Science Teacher*, April 1960). The Committee on Innovation in Laboratory Instruction was organized as a part of the Curriculum Study and

assigned the task of developing a new approach to laboratory instruction.

Dr. Bentley Glass of Johns Hopkins University, who is a member of this Committee,¹ as well as chairman of the Steering Committee for the entire Curriculum Study, suggested the organization of a series of laboratory experiences covering a definite "block" of time which would permit the student to study a specific biological problem as a biologist might study if he were starting with the same level of knowledge as the student. The Committee has called this approach "the laboratory block" and is developing a series of blocks, each of six-weeks duration.

From the teacher's point of view, use of the laboratory block will mean condensing the work usually given in 36 weeks to 30 weeks. It is felt that this can conveniently be done, particularly with the use of modern teaching techniques, audio-visual aids, and well-planned laboratory demonstrations.

From the student's point of view, the use of the laboratory block will permit him to experience the nature and methods of science—to make discoveries for himself. The laboratory blocks are designed around a series of questions posed but not answered. The student carries out a series of experiments, makes observations, and collects data. This information may then be interpreted by the student to provide answers to the questions which were raised. While this approach is exciting

and does follow the pattern of study a scientist might follow studying the same problem, a word of caution is indicated to both the students and teachers. In the laboratory block some decisions having to do with experimental design, techniques, and use of equipment which the scientist would make for himself, are given in detail for the student. We believe that this is necessary at this level because of the teaching limitations mentioned earlier, and we do not wish to give the student the false impression that he is a scientist if, indeed, he is not. On the other hand, we have tried to lose no opportunity to suggest in the laboratory blocks to the student the possibility of more detailed experiments or additional ones. These suggestions are completely open-ended.

In the development of the laboratory block, the Committee has requested active research scientists to provide the initial material for the laboratory block. The preliminary block is then turned over to a staff of experienced high school teachers who are working full-time in a special laboratory set up by the BSCS at The University of Texas trying out the materials submitted. The project associates who are doing this work are James Dawson, Richard Barthelemy, and Don Borron. They do the experiments designed under various conditions and with such modifications as they think may make them practical for use in the high school laboratory. Recommendations are then given to the author and revisions are made. The laboratory blocks are then "pre-tested" in a special class by another teacher and additional revisions made when needed. The laboratory blocks are then ready for general testing in the national BSCS program.

Four separate laboratory blocks were prepared and used in this testing program during the past year. These are: (1) *Microbes: Their Growth, Nutrition, and Interaction* by Alfred S. Sussman; (2) *Interdependence of Structure and Function—A Study of Motion* by A. Glenn Richards; (3) *Animal Growth and Development* by Florence Moog; and (4) *Plant Growth and Development* by Addison E. Lee and Irwin Spear. The nature and content of these blocks can be described

¹ Members of the Committee are: Addison E. Lee, The University of Texas, Austin, *Chairman*; Harper Follansbee, Phillips Academy, Andover, Massachusetts; Bentley Glass, Johns Hopkins University, Baltimore, Maryland; William P. Jacobs, Princeton University, Princeton, New Jersey; Florence Moog, Washington University, St. Louis, Missouri; Edwin A. Phillips, Pomona College, Claremont, California; A. Glenn Richards, University of Minnesota, Minneapolis; Alfred S. Sussman, University of Michigan, Ann Arbor.

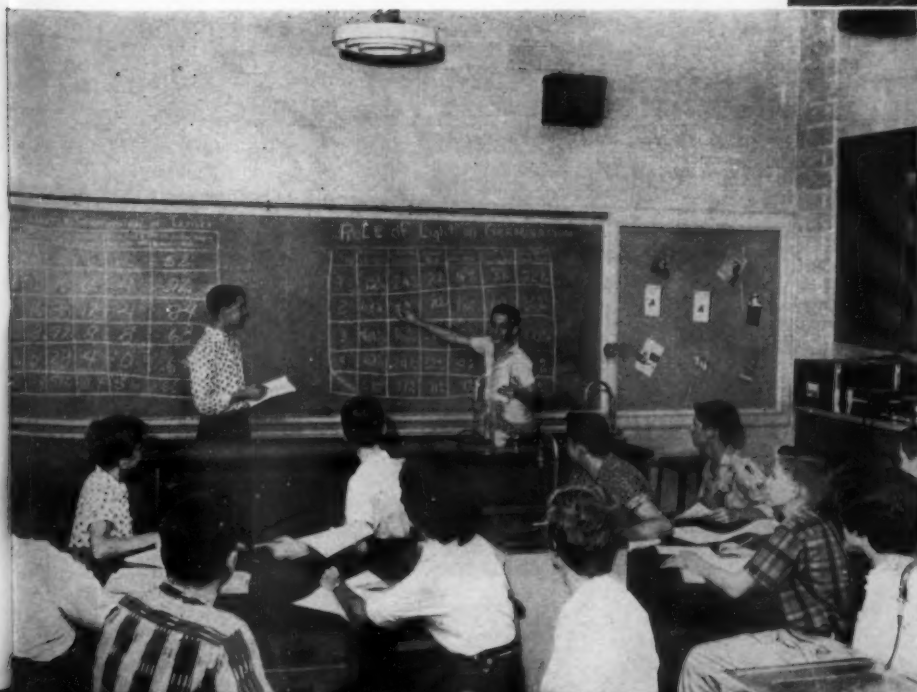
The Austin staff of the BSCS Committee on Innovation in Laboratory Instruction reviews recent publications of the Committee. (l. to r.—Richard Barthelemy, Project Associate; Don Borron, Project Associate; Addison E. Lee, Project Supervisor and Committee Chairman; and James Dawson, Project Associate.)



Austin, Texas, high school students study the growth curve obtained from population studies in the laboratory block on Microbes.



A Madison, Wisconsin, high school student removes frog testis to be used in fertilizing frog eggs in the laboratory block on Animal Growth and Development.



Alamo Heights, Texas, high school students discuss a summary of data obtained by the different squads studying the effect of light on germination of lettuce in the Plant Growth and Development block.

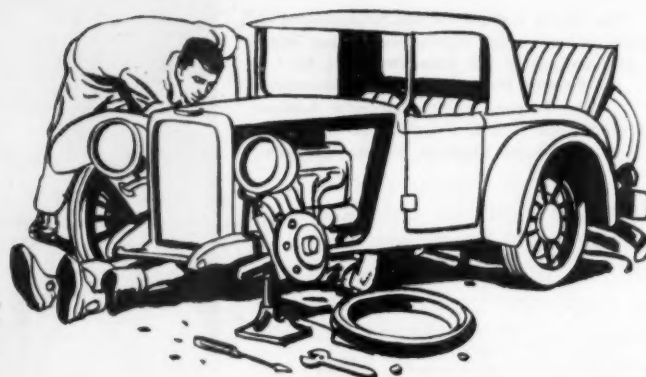
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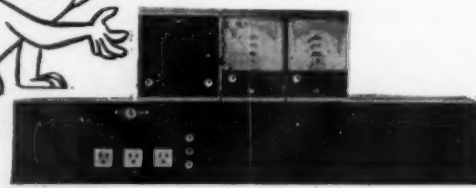
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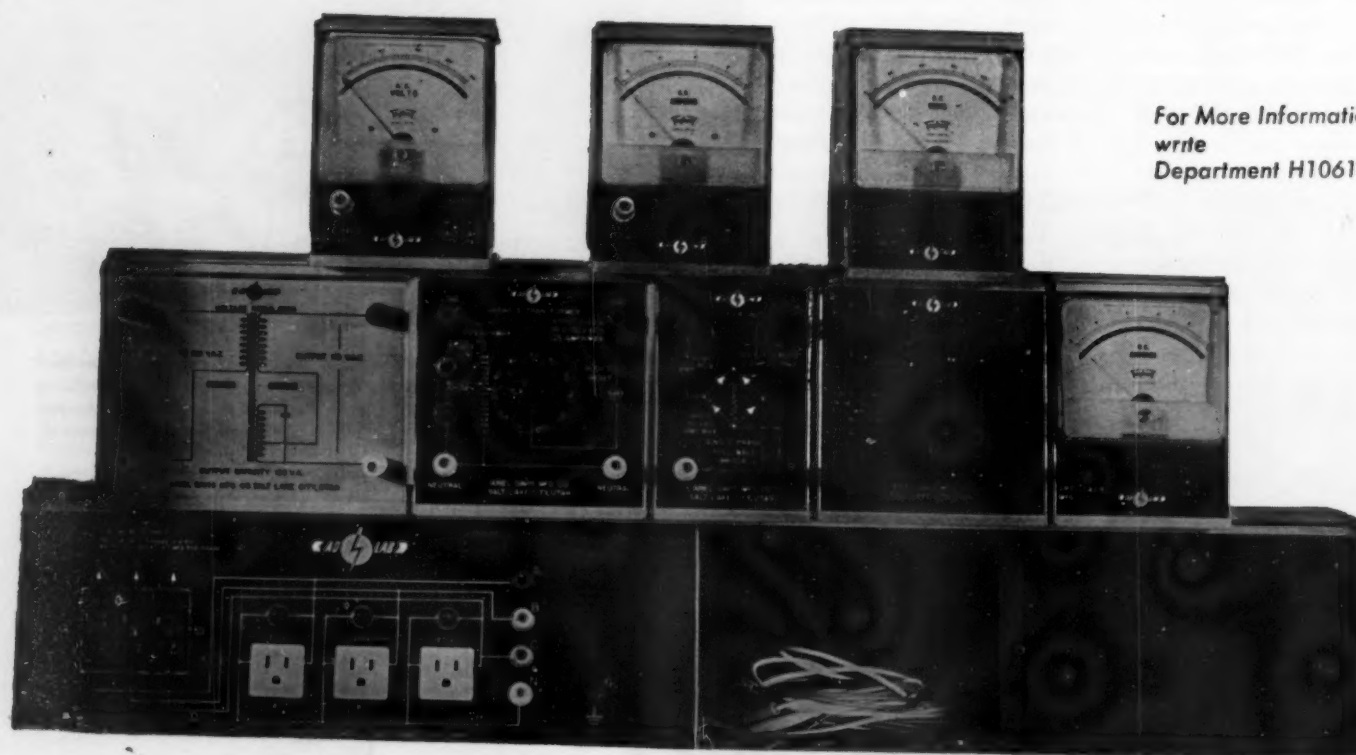
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best by a few quotations and comments about each.

The introduction to the block on Microbes says:

Microorganisms represent the extremes of cooperation and conflict, both with their environment and with man. Some aspects of these omnipresent creatures and of their interactions with other organisms are already familiar to you from your own experience. One purpose of these exercises will be to describe microbes in more detail. Another purpose, and perhaps the more important one, is an introduction to the analysis of key biological problems through the use of microbial materials. A 'microbe-eye' view of living things can, in many cases, help you see more clearly *how* and *why* larger living things, including man, function as they do.

In this laboratory block the student is introduced to microbes through an exploration of their habitats in nature from which pure cultures are obtained. Then the population growth of a single species (yeast) is determined. Nutritional deficiencies are analyzed by auxanographic techniques. Interactions among known and unknown organisms are investigated. The use of controls in the isolation of single variables is included in the design of the actual experiment. The uses of observations, measurements, graphing, simple statistical testing, and other calculations are involved in the analysis which the student makes of his own data.

In the block on *Interdependence of Structure and Function—A study of Motion*, six sections are included. The section on lever systems gives a discussion of levers, measurements and errors, and an examination of a muscle-lever system by dissection.

In the section on locomotion involving levers, Dr. Richards deals with problems of standing still, then walking, and running. Muscular movements without levers are considered—movement by pressure changes. What is the mechanism involved in breathing? How does the housefly retract and extend his proboscis? Non-muscular movement (cilia, protoplasm) and movements in plants (opening and closing of stomata, ascent of sap) are investigated. Finally, a detailed investigation of muscle structure and function, including the chemical energy machine, is carried out. Would you like to see

mitochondria? It tells how on Page 118—and you don't need an electron microscope to see the mitochondria!

The block on *Animal Growth and Development* uses both a standard observational approach and an experimental approach in a study of the growth and development of the frog and of the chick. Some interesting questions Dr. Moog asks include: "Can eggs develop without fertilization? Can very young embryos develop with little or no oxygen? What are the affects of various hormones and inhibitors on development? Temperature? Does the rate of a chick heartbeat increase in proportion to temperature? Does a tadpole have to practice to learn to swim? Can we demonstrate cytochrome-oxidase activity in young chick embryos? When and where?"

Here are some of the key questions raised for investigation for the student in the laboratory block on *Plant Growth and Development*. What is growth? What is development? Is it the same as growth or does growth result in development? Why will some seeds germinate while others will not? What is the nature of the germination process and the pattern of growth which follows? What factors affect the process? What are the characteristics of plant growth? Just how can one measure the growth of plants? What is the internal organization of the plant and how is it related to growth and development? Can growth in multicellular organisms occur without cell specialization? What are the requirements for growth and development? How are growth and development regulated?

During the spring semester of 1961 these four laboratory blocks were tried out in eight of the BSCS testing centers: New Brunswick, New Jersey; Baltimore, Maryland; Madison, Wisconsin; Jefferson County, Colorado; Phoenix, Arizona; Los Angeles, California; San Francisco Bay Area, California; and Houston, Texas. Approximately 56 teachers and 7000 students were involved in this program.

Following the testing period the teachers provided us with their reactions and comments concerning their experiences in using the laboratory blocks. They also provided us with data the students obtained and student reaction. In general it is fair to say that the reaction of both students and teachers to the block was a combination

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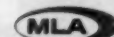
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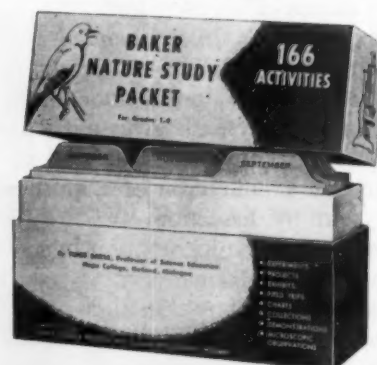
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of enthusiasm and frustration; enthusiasm because they appeared to achieve the objectives set up for the program (and perhaps to some extent because of the newness of the approach); frustration because of the extra work required, limitations which were often present in the form of facilities and equipment, and the lack of experience of teachers in carrying out this type of program. On the positive side, however, it should be noted that we have some evidence and a firm belief that the second time a given teacher teaches one of the laboratory blocks the work involved will be considerably less difficult and frustrating.

The following quotation is from a letter sent to the Committee Chairman from one of the teachers doing the laboratory block with five classes under somewhat difficult physical conditions.

Our hectic year is over, but I feel that I must drop you this note concerning the block program. I realize that you may have had the impression that the laboratory block was too sophisticated for some of our groups and that our facilities were too cramped for success. However, the students seemed to have gotten something intangible out of this in spite of the handicaps—something not measurable by tests. Here are some typical responses from various groups in my classes:

Top Group—Most students in this group have IQ's above 130

'For the first time I have really had to think. I am just beginning to know what science is.'

High Average Group Underproducers—mostly boys

The students in this group were the only ones who did not respond, even to the block. Their grades in their other subjects were also poor. They should never have been put together in one section as they helped each other underproduce.

Average College Preparatory Group

'Although the words were hard, I was willing to spend time looking up the meanings because the laboratory was so interesting.'

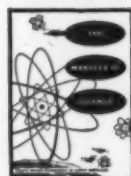
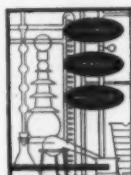
Slow College Preparatory Group

When asked how many would have preferred not to have had the block not one hand went up. This is the class that always had to do everything twice because they did it wrong the first time. However,

this is the class which showed the most improvement in study, preparation, attitude, and test results following the block. I believe that for the first time they realized that the directions were there for a purpose. This started them to trying to read with understanding. At any rate, the quality of their work for the rest of the year showed a marked improvement.

Not only did the feedback information contain reactions of students and teachers to the laboratory blocks, it

also contained specific suggestions for modification of some of the experiments and activities. All of this feedback was analyzed and the laboratory blocks were revised during the summer period. Revised editions are being tried out in a much larger number of schools this year. There are 17 test centers involving approximately 150 teachers and 16,000 students. At this time there is also a special testing and evaluation program being developed with the help of the Education Testing Service to evaluate more thoroughly



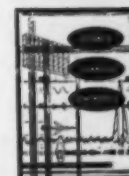
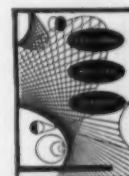
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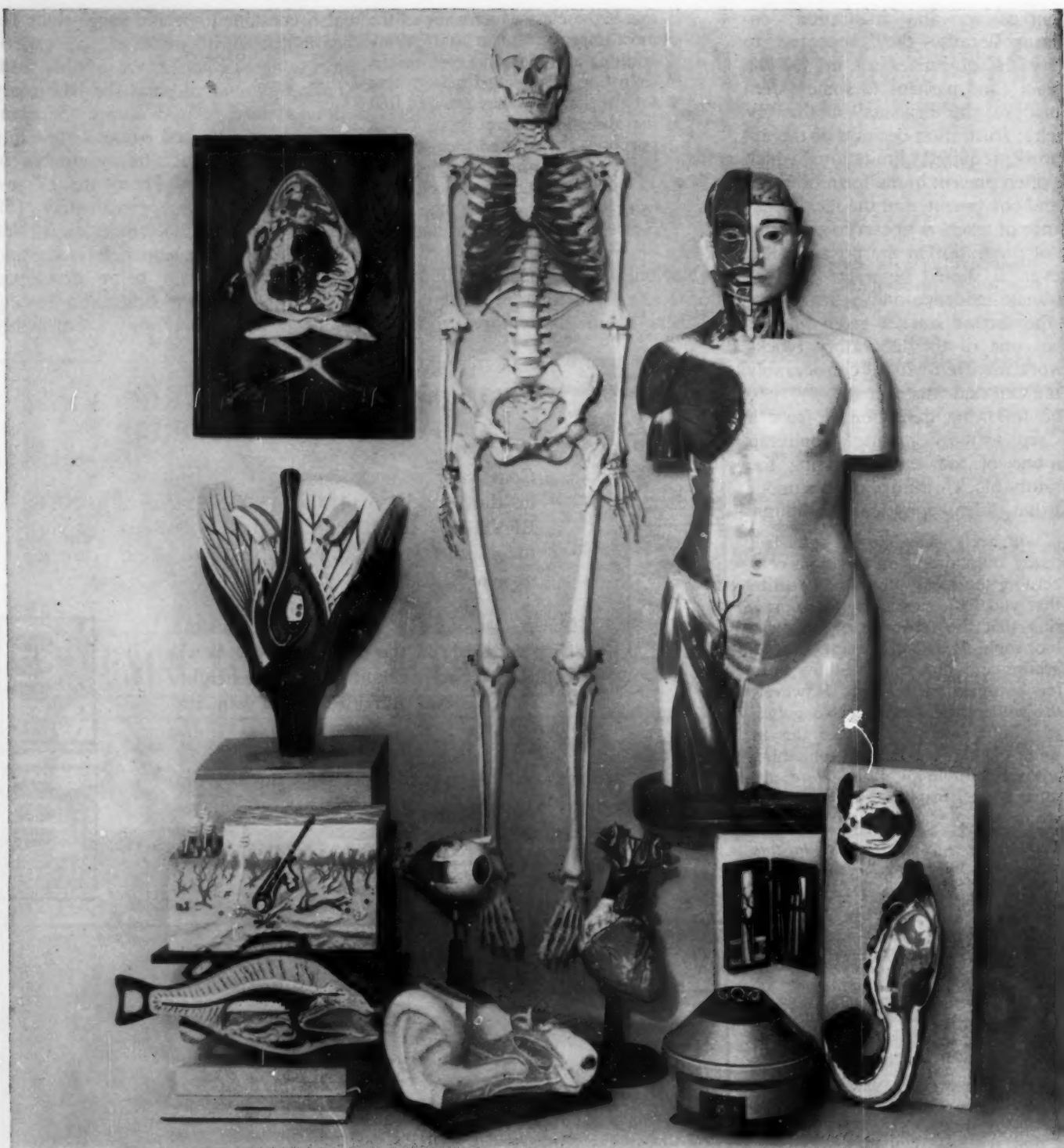
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the effectiveness of the laboratory blocks in the BSCS program.

In addition to the laboratory blocks described in detail above, three others have been written in preliminary form and are being tried out on a limited basis this year. They are (1) *The Ecology of Land Plants and Animals* by Edwin A. Phillips, (2) *Animal Behavior* by Harper Follansbee, and (3) *Regulation in Plants by Hormones* by William P. Jacobs and Clifford E. LaMotte. Laboratory blocks in the process of preparation include one on *Genetic Continuity* being developed by Bentley Glass and one on *Physiological Adaptation in Animals* by Earl Segal.

We have high hopes for the success of this laboratory teaching technique. It is true that the laboratory blocks will

surely be more effective in some situations than in others. Like any other program, however, their success will depend on optimum support from the teachers who are using them. It is our hope that teachers who use the laboratory blocks will do so with the same pioneer spirit that the Committee, its consultants and staff have had in developing them. This spirit is exemplified by the expression of one teacher who tried an experiment in one of the laboratory blocks recently. He was willing to try the experiment but was quite skeptical of its success. To his surprise, the successful completion of the experiment was more overwhelming to him that it actually could be done than it was for the students.



As a regular feature of *The Science Teacher*, the calendar will list meetings or events of interest to science teachers which are national or regional in scope. Send your dates to TST's calendar editor as early as possible.

October 6-7, 1961: NSTA Regional Conference, Bradford Hotel, Boston, Massachusetts

October 13-14, 1961: NSTA Regional Conference, Sheraton Hotel, Portland, Oregon

October 20-21, 1961: NSTA Regional Conference, Netherland Hilton Hotel, Cincinnati, Ohio

October 26-27, 1961: Association for the Education of Teachers in Science, Annual Fall Regional Meeting, Columbia University, New York City

November 5-11, 1961: American Education Week, Theme: Your School—Time for a Progress Report

November 23-25, 1961: 61st Annual Meeting, Central Association of Science and Mathematics Teachers, Sheraton Chicago Hotel, Chicago, Illinois

December 26-30, 1961: NSTA Annual Winter Meeting in conjunction with 128th meeting of the American Association for the Advancement of Science, Denver, Colorado

January 24-27, 1962: Annual Meeting, American Association of Physics Teachers, Statler-Hilton Hotel, New York City (Joint meeting with the American Physical Society)

February 21-24, 1962: 35th Annual Meeting, National Association for Research in

Science Teaching, Willard Hotel, Washington, D. C.

March 9-14, 1962: NSTA Tenth Annual National Convention, San Francisco, California

April 15-18, 1962: 40th Annual Convention, National Council of Teachers of Mathematics, Jack Tar Hotel, San Francisco, California

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Atomic Arrangement in Solids

By MAYNARD P. BAULEKE, University of Kansas, Lawrence, Kansas

Bubble rafts are a useful demonstrational tool for showing the two-dimensional arrangement of atoms in solids. Unfortunately, many science teachers look upon the construction of the raft and the formulation of the soap solution as difficult and time-consuming. For many atomic arrangements, an adequate raft can be made with the equipment available in any science laboratory. The basic equipment needed is:

1. Bubble solution; available from any variety store.
2. Flat-bottom dish. A rectangular dish is preferred, but a round Petri dish is satisfactory.
3. A capillary tube; make by drawing down a piece of glass tubing.
4. Rubber tubing.
5. Low-pressure gas that is relatively insoluble in the bubble solution.

Bubbles are blown by inserting the capillary tube beneath the surface of the solution and allowing gas to escape

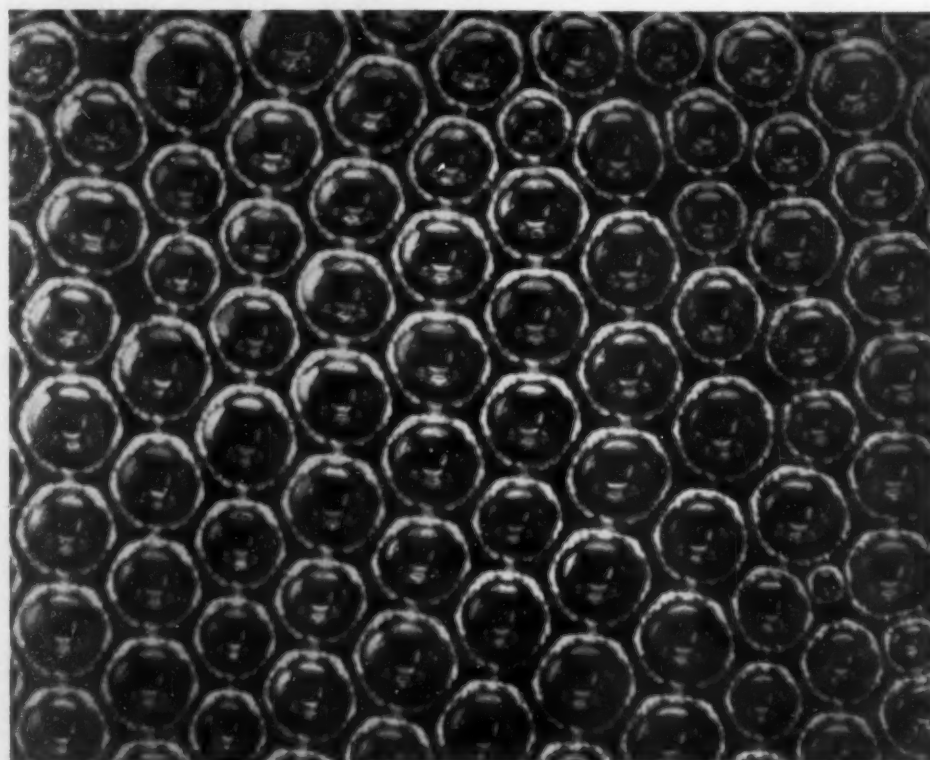
into the solution. A constant depth and a constant gas pressure are required to produce uniform-sized bubbles. It takes practice to produce uniform bubble areas. Figure 1 shows a typical bubble pattern. Notice how the arrangement adjusts to accommodate various sizes. The same arrangement occurs in metal alloys in which metal atoms of various sizes are packed together. An overhead projector may be used to project the raft onto a screen whenever necessary to have group viewing.

Various gases may be used for blowing the bubbles; air, nitrogen, or on occasions even natural gas. Carbon dioxide is too soluble to produce stable bubbles.

The bubble raft is a useful visual aid to explain the following:

1. Attraction of atoms within a liquid by surface tension to create an orderly arrangement and produce a solid structure.
2. Efficient packing of atoms in a solid.
3. Formation of grain boundaries within a polycrystalline material.
4. Coordination of various sized atoms within a solid.
5. Development of dislocations (defects) within a crystal structure.
6. Diffusion of atoms within a solid.
7. Production of solid solutions.
8. Thermal motion of atoms within a solid. Best shown by slight movement of the raft causing motion of the bubbles.

FIGURE 1. Typical bubble arrangement. Imperfections are best observed by holding the picture at a grazing angle to eye level and looking down the rows.



Classroom

IDEAS



Biology

Quantitative Measurements in Biology

By ASHLEY G. MORGAN, Jr., State Department of Education, Atlanta, Georgia

One of the major difficulties between the biological and physical sciences is the lack of quantitative measurements in biology classes. Many students complete a high school biology course and never know the microscope is not simply a magnifying device, but also a measuring instrument. Generally, biology students have very little understanding of the size of specimens viewed with the microscope, the units used to measure them, or the relationship of these units to those the students commonly use in their work.

The purpose of the technique outlined below, therefore, is to give the student a comprehensive knowledge of the relationships.

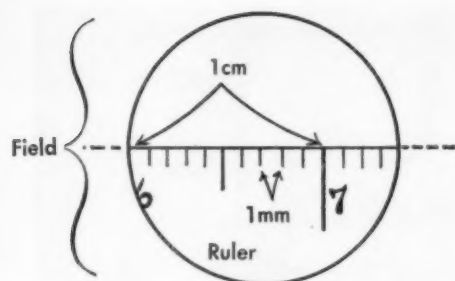


FIGURE 1.

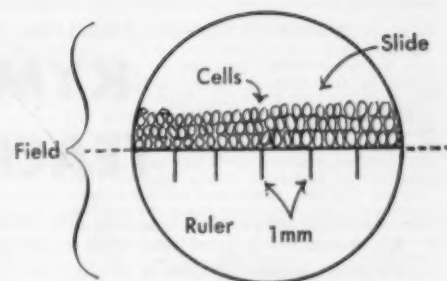


FIGURE 2.

ameter of the field by the apparent diameter of the field; *i.e.*, $670 \text{ mm} \div 14 \text{ mm} = 48\text{X}$ (times). This step is necessary only if one wishes to know how many times a specimen is magnified. This information cannot be accurately inscribed on the objective of a microprojector as it can on a microscope.

The medium power (MP) and high power (HP) objectives may also be utilized in the same manner as given above. Data obtained with the microprojector are as follows:

a. MP field = 13 mm = 13,000 μ .

Actual screen field:

$1020 \text{ mm} = 1,020,000 \mu$.

Magnification:

$\frac{1020 \text{ mm}}{13 \text{ mm}} = 78.5\text{X}$.

b. HP field = 6 mm = 6000 μ .

Actual field:

$920 \text{ mm} = 920,000 \mu$.

Magnification:

$\frac{920 \text{ mm}}{6 \text{ mm}} = 153.3\text{X}$.

Using the HP objective and a temporarily mounted onion skin, the following procedure was used to determine the actual (average) size of the cells composing the skin. Any permanent or temporary specimen may

be used. The onion skin was chosen because the cells are fairly large, it is readily available, and easy to mount on a dry and uncovered slide.

The author has used one such "temporary" mount for the past year in demonstrating before numerous elementary and high school students and teacher groups.

B. Cell size:

1. After measuring the HP field with the plastic ruler, remove the ruler and place the slide on the stage. Focus as necessary.
2. Place the ruler over the slide so that the rulings are visible. Adjust the ruler and slide to place a row of cells parallel to the edge of the ruler. (Figure 2.)
3. Count the number of cells seen on the screen lying

I. Materials

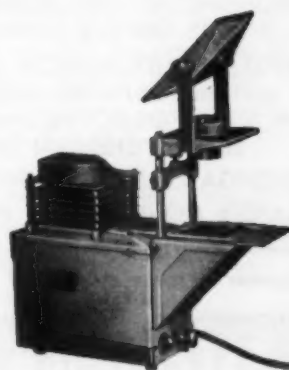
Microscopes, microprojector, screen, microscope slides, clear plastic ruler with both millimeter (mm) and inch (in) markings, and a meter stick. (In gathering the following data, the author used a tri-simplex microprojector and student microscope, both with three objectives.)

II. Procedure

A. Microprojector magnification:

1. Set up the microprojector about 2 meters (m) from the screen. If the projector is farther from the screen, greater magnification is obtained with a particular objective but the amount of illumination of the screen is reduced.
2. Turn on the projector and adjust stage for maximum light field on the screen.
3. Place the plastic ruler on the stage so that the rulings (mm or in) may be seen, using the low power (LP) objective, focus the lens.
4. Adjust the ruler in a manner that will make one ruling tangent to the circumference of the field on the screen. (Figure 1.)
5. The number of rulings seen on the screen gives the apparent diameter of the field; *i.e.*, $1.4 \text{ cm} = 14 \text{ mm} = 14,000 \mu$ (microns). ($1 \text{ mm} = 1000 \text{ microns}$.)
6. Using the meter stick, measure the actual diameter of the field projected on the screen; *i.e.*, $67 \text{ cm} = 670 \text{ mm} = 670,000 \mu$.
7. Calculate the magnification by dividing the actual di-

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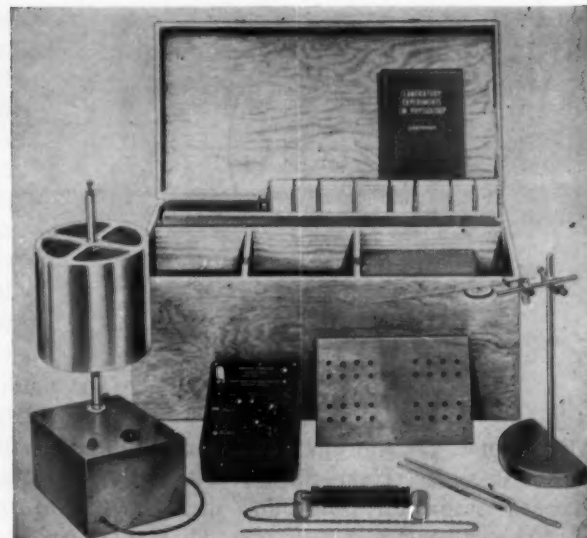
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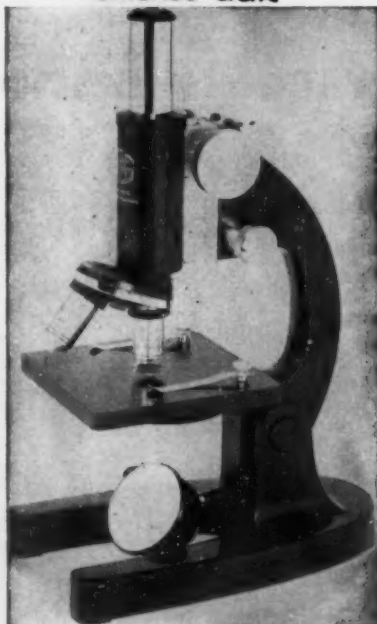


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end to end between two successive mm markings. (Figure 2.) Since all of the cells are not the same length, you may desire to count several rows (4 or 5) and take the average number as a start.

4. Divide 1 mm by the number of cells in 1 mm to compute the length of the average cell; i.e., $1 \text{ mm} \div 4 = 0.250 \text{ mm}$ in length per cell or 250μ .
5. To measure the diameter (width) of the cells, arrange the ruler and slide so the cells are side by side between two successive mm markings. Then, refer to (4) above for the next step; i.e., $1 \text{ mm} \div 15 = 0.0667 \text{ mm}$ width per cell or 66.7μ .

C. Measuring cell size with the microscope:

The procedure with a microscope is quite similar to that outlined above. Magnification is given on the objective. The field of view on the microscope is considerably smaller than on the microprojector. Using the two-objective microscope and the method described above, the following data was obtained and recorded:

1. LP—diameter of field = $1.2 \text{ mm} = 1200 \mu$.
Number of cells in line between mm markings = 4.
Average length of cell = $\frac{1.0}{4} = 0.250 \text{ mm}$ or 250μ .
2. The 10X eyepiece and the LP (10X) objective give the combined magnification of 100X. Likewise, the eyepiece and the HP (43X) objective give a total magnification of 430X. Higher magnification reduces the size of the field. Since 43X is 4.3 times greater than 10X, the LP field is 4.3 times larger

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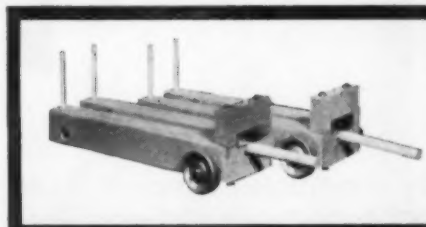
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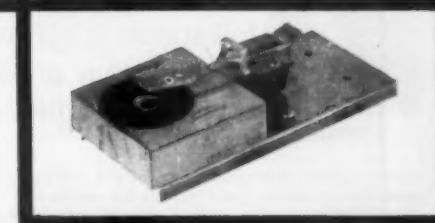
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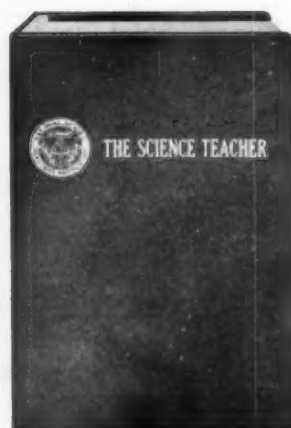
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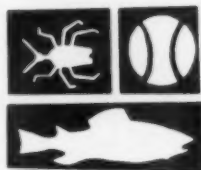
than the 43X (HP) field. Therefore, the HP field diameter is:

$$\frac{1200 \mu}{4.3} = 279 \mu,$$

or 0.279 mm.

The field diameter of HP would not accommodate a single onion skin cell lengthwise, but four such cells could be viewed side by side. Also using HP, one could see about forty red blood cells in a row.

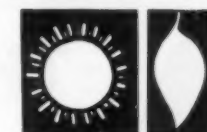
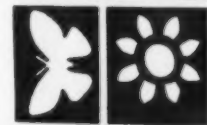
3. If the microscope has a calibrated fine adjustment (usually 1 division = 0.002 mm or 2 μ), cell depth or thickness can be measured by first focusing on the upper cell wall and then on the lower cell wall, observing the number of divisions the fine adjustment is moved. This requires practice in order to get the proper perspective in focusing.



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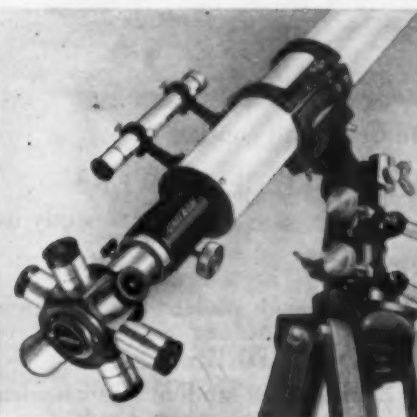
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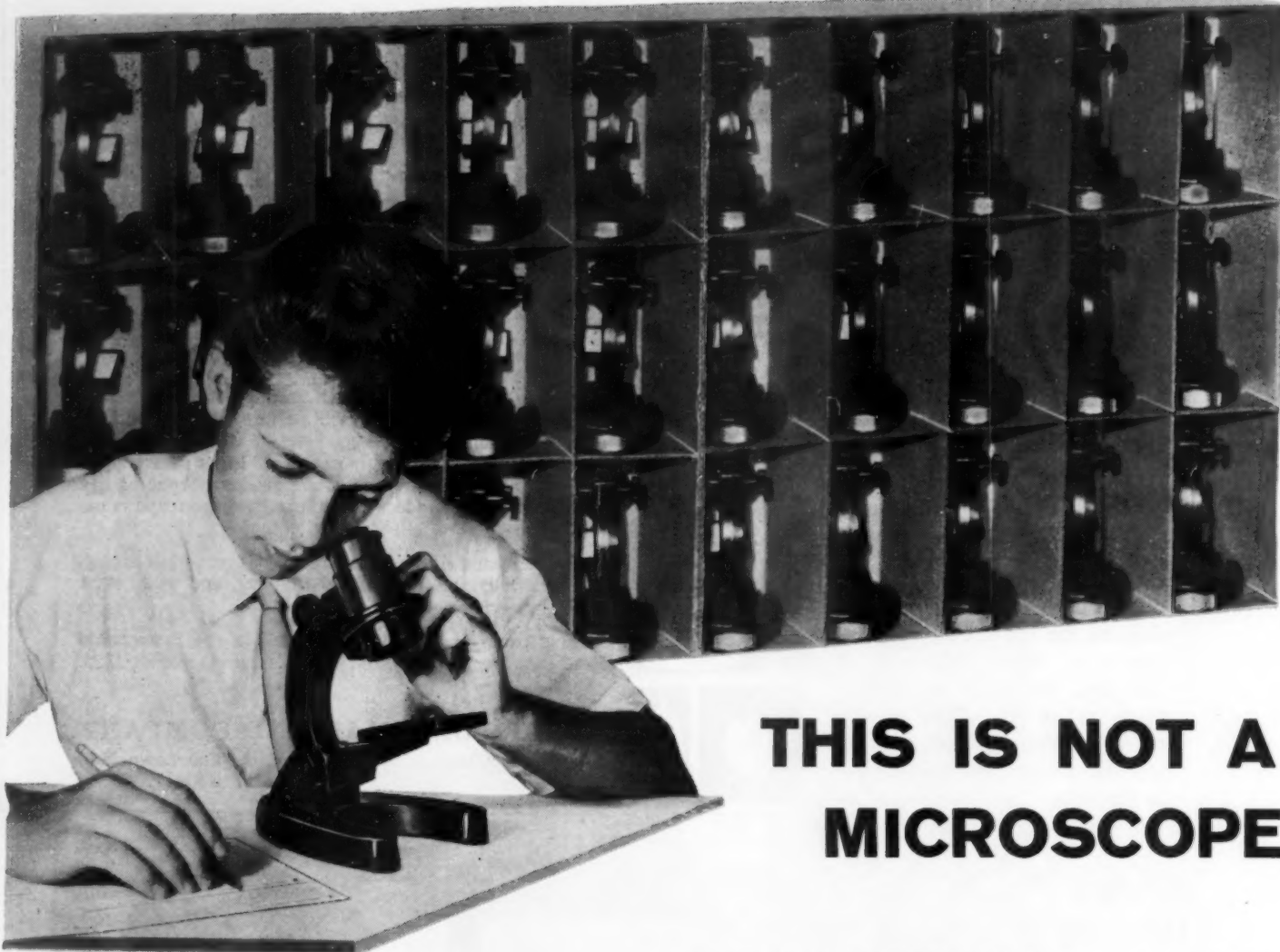
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AETS Regional Meeting

The word from the Association for the Education of Teachers in Science is G-R-O-W-T-H. One new regional section is in the process of calling its first meeting and a second is in the organization planning stage.

A meeting of the newly formed Southern California Regional Section of AETS will be held at San Diego State College, California this fall. Section officers are: *President*, Jack Smith, San Diego State College; *President-elect*, Albert Lindquist, Los Angeles State College of Applied Arts and Sciences; *Secretary-Treasurer*, Charles Heimler, San Fernando Valley State College.

In conjunction with the Regional Meeting of NSTA in Lincoln, Nebraska, September 22-23, an organizational meeting for another AETS Section will be held during that time.

Eastern Regional Section will hold its fall meeting October 27-28 at Teachers College, Columbia University, New York City. Officers for the Eastern Section are: *President*, Victor Crowell, Trenton State College, New Jersey; *President-elect*, David S. Sarner, Keene Teachers College, New Hampshire; and *Secretary-Treasurer*, Jay Erickson, Teachers College, Columbia University, New York City.

AETS officers for 1961-62 are: *President*, Fletcher Watson, Graduate School of Education, Harvard University, Cambridge, Massachusetts; *President-elect*, Willard Jacobson, Teachers College, Columbia University, New York City; and *Secretary-Treasurer*, Harold Spielman, School of Education, College of the City of New York.

Chapters and Affiliated Groups

Proposals for the enrollment of science teacher organizations as chapters or affiliates of NSTA (see October 1960 *TST*, p. 45) have now been refined into workable procedures and seven such groups have already taken official action to join forces with the national association.

Enrolled as state chapters of NSTA are the following:

Arizona Science Teachers Association
Colorado Science Teachers Association
Science Teachers Association of New York State, Inc.
Texas Association of Science Teachers
Washington Science Teachers Association

The following organizations have voted to establish or continue affiliated group status under the new plan:

Association of New Brunswick Science Teachers (Canada)
Ontario Science Teachers Association (Canada)

A distinctive plaque of modern design will be presented to each of the above groups as a symbol of mutual agreement to work cooperatively in extending and improving science education for all. Other interested groups, whether already affiliated with NSTA or not, are invited to write to the Executive Secretary for more information and enrollment forms.

An important feature of the new plan, and one that promises to have great potential for positive action, calls for an annual work conference for delegates of chapters and affiliates. An initial, pilot-run conference of this proposed National Advisory Council on Science Teaching will be held next July during one or two days preceding the annual business meeting of the NSTA Board of Directors. Time, place, and program details are still to be worked out and will be announced in this column. Meanwhile, suggestions as to suitable agenda items, problems, issues, or other items will be most welcome. These provide direction for NSTA in suggesting chapter procedures.

AAAS Meeting

The annual joint meetings of NSTA and other science teaching societies affiliated with the American Association for the Advancement of Science will be held in Denver, Colorado, at the Shirley Savoy Hotel. Room reservations for those plan-

ning to attend December 26-30, 1961, should be made by writing to the AAAS Housing Bureau, 225 West Colfax Avenue, Denver 2, Colorado. Details of the sessions of the teaching societies, as well as those of scientific societies meeting with AAAS, will be published, in full, in the AAAS General Program. No separate program for the science teaching groups will be printed.

The general theme of all NSTA sessions is **VISTAS OF SCIENCE**. The five sessions planned in accordance with this theme are:

I. Vistas of Earth Science, December 27.

2:00 p.m. Colorado Room

Chairman: Rodney F. Mansfield, Consultant, Science and Mathematics, State of Colorado, Department of Education, Denver, Colorado.

Speaker: Norris W. Rakestraw, Dean, Graduate Division, Scripps Institute of Oceanography, University of California, La Jolla, California.

THEME: *The Chemist in Oceanography*.

Panelists: James R. Wailes, School of Education, University of Colorado, Boulder, Colorado; John Marean, Reno High School, Reno, Nevada, *President-elect*, NSTA; Donald W. Stotler, Science Supervisor, Portland Public Schools, Portland, Oregon.

II. Vistas of Science Facilities, December 28.

9:00 a.m. Colorado Room

Chairman: William W. Day, University High School, University of Wyoming, Laramie, Wyoming.

Speaker: Fred R. Schlessinger, Director, Second NSTA Science Facilities Study, College of Education, The Ohio State University, Columbus, Ohio.

THEME: *New Trends in Science Facilities*.

Panelists: Paul DeH. Hurd, School of Education, Stanford University, Stanford, California; Louise A. Neal, Professor of Elementary Science, Colorado State College, Greeley, Colorado.

III. Vistas of Space Science, December 29.

9:00 a.m. Colorado Room (Co-sponsored by National Aeronautics and Space Administration)

Chairman: Lavar L. Sorensen, Science Supervisor, Salt Lake City Schools, Salt Lake City, Utah.

Speakers: Nelson Spencer, National Aeronautics and Space Adminis-

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tration, Goddard Space Flight Center, Greenbelt, Maryland.

THEME: *Modern Space Science.*

James V. Bernardo, Chief, Educational Services Branch, National Aeronautics and Space Administration, Washington, D. C.

THEME: *Teaching Materials and Techniques in Space Science.*

IV. Vistas of Science Curricula, December 30.

9:00 a.m. Colorado Room

Chairman: Joseph A. Struthers, Vice President, Colorado Science Teachers Association, Colorado Springs, Colorado.

Speakers: Donald G. Decker, Dean of the College, Colorado State College, Greeley, Colorado.

THEME: *The NSTA Curriculum Study Plan.*

Joseph Zaffaroni, Associate Professor of Elementary Education, The Pennsylvania State University, University Park, Pennsylvania.

THEME: *The Elementary Science Curriculum.*

Henry Angelino, College of Education, University of Oklahoma, Norman, Oklahoma.

THEME: *NSTA Findings from Film Research Program.*

V. Luncheon Meeting, Colorado State Teachers Association, December 30.

12:00 p.m. Colorado Room

Chairman: Joseph Pierce, President, Colorado Science Teachers Association, Durango, Colorado.

Speaker: J. Darrell Barnard, President, NSTA, New York University, New York City.

Besides the NSTA sessions, three joint meetings will be held with the National Association for Research in Science Teaching (NARST), the National Association of Biology Teachers (NABT), and the American Nature Study Society (ANSS). These sessions will be held in the Lincoln Room of the Shirley Savoy Hotel and include joint meetings on December 27, at 9:00 a.m. and at 2:00 p.m., and a Mixer on December 27 at 5:00 p.m. Local coordinator for all joint sessions is Dr. Sam Blanc, Gove Junior High School, Denver, Colorado.

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Reviews

High School Biology. James A. Moore, Supervisor, *et al.* 8 volumes. Texts (2 basic books), 554p., \$2.75; Laboratory Manuals (3 books, 84 experiments), \$4.50; Teachers' Guides (3 books), \$4.50; Set \$11.75. Paperbound. Yellow Version (Identity of subject matter). American Institute of Biological Sciences, Biological Sciences Curriculum Study, University of Colorado, Boulder, Colo. 1960-61.

The eight-volume preliminary Yellow Version is slanted toward a developmental and genetics approach. It covers in sequence: Preview of Biological Problems, Biology of Man, Biology of Green Plant, and Matter, Energy, and Life, Subvisible World of Microorganisms, Diversity of the Animal Kingdom, Diversity of Plants, Genetics, Reproduction, Evolution, and terminates with Essays on Biology. Version starts with the whole organism, man, and approaches the study of organisms, both animal and plant from the point of view of function related to structure, thus stressing unity within diversity. Committee members, none of whom is associated with BSCS group, reviewed the first experimental version, which was released during the period of September-April 1961. Included are some of the Committee's comments. The large (8½ x 11½ inches) nonglare, page is easily read but use of vocabulary is not consistent as level varies from section to section of the volumes. The combination of fine line drawings plus photographs increase the clarity of text. The integrated laboratory manual gives short, concise experiments which are understandably written and for which specific questions are asked in conclusion. Fine line drawings in manual demonstrate difficult techniques or laboratory set up. The teachers' guide is coordinated with each laboratory exercise pointing out the purposes, material needed, and difficulties or variations of each exercise. The scope of the material is adequate but the value lies in the depth of material presented. Chemistry is woven throughout and will be a real challenge to tenth-grade students to experiment or explore.

ROBERT WASSELL
Weatherwax High School
Aberdeen, Washington

High School Biology. Marston Bates, Supervisor, *et al.* 9 volumes. Texts (3 basic books), 546p., \$3.75; Laboratory Manuals (3 books), \$4.25; Teachers' Guides (3 books), \$4.75; Set \$12.75. Paperbound. Green Version (Indicates identity of subject matter). American Institute of Biological Sciences, Biological Sciences Curriculum Study, University of Colorado, Boulder, Colo. 1960-61.

This version of the BSCS high school biology curriculums builds the course around ecological principles and stresses the essential relatedness of all living things to each other and to their environment. Chapter headings in texts include: The World about Us; Individuals, Populations, and Communities; Animal Diversity; Plant Diversity; Microscopic Life on Land; Life in the Seas; Biogeography; Biohistory; The Cell; Heredity; Evolution; Plant Physiology and De-

velopment; Animal Physiology and Development; Animal Behavior; The Human Animal; and Economy and Ecology. Our evaluating committee, composed of high school biology teachers, none of whom is connected with the BSCS Committee, reviewed the nine-volume, first experimental version, released September 1960 through spring 1961. The nonglare paperbound edition is designed for the tenth grade reading level with appropriate vocabulary expanded to facilitate the more detailed chapters. Texts and laboratory manuals include line drawings and halftone illustrations. The laboratory exercises parallel the work in the texts and include both indoor laboratory exercises and field experiences. Teachers' guide provides adequate integration with text and laboratory manuals, pointing out purpose, aids to topics, and also provides a list of scientific articles pertinent to many text and laboratory chapters. The Green Version is not such a departure from the present day tenth grade biology course and is less dependent on chemistry. Because of this, it may be more acceptable to many present-day biology teachers than are the other two versions (Blue and Yellow).

HERBERT J. MORGAN
Grand Haven High School
Grand Haven, Michigan

BSCS High School Biology. Ingredh Deyrup, Supervisor, *et al.* 9 volumes. Texts (3 volumes), 488 p. \$3.50; Laboratory Manuals (3 volumes), \$3.75; Teachers' Guides to Laboratory Manuals (3 volumes), \$4; Complete Set (9 volumes), \$11.25. Paperbound. Blue Version (Indicates identity of subject matter). American Institute of Biological Sciences, Biological Sciences Curriculum Study, University of Colorado, Boulder, Colo. 1960-61.

An evaluation committee composed of high school biology teachers who have not participated in the formulation or testing of BSCS materials reviewed this version which was released in September 1960 and spring of 1961. The Blue Version develops fundamental biological concepts with emphasis placed on the ideas and experimental approach of physiology and biochemistry. This version, like the others (Yellow and Green), is of an experimental nature and was to have been revised this past summer. Following is a listing of the section titles: (1) The Biologist Looks at the World, (2) On Being Alive, (3) The Composition and Organization of Living Things, (4) The Quest for

Energy, (5) The Uses of Energy, (6) Functions and Organization of Man, (7) Genetics, (8) Reproduction and Development, (9) Evolution, and (10) Biology—Known and Unknown. Of the three versions, the Blue departs most sharply from current biology courses. This is manifest in the stress placed on biochemistry. The advanced nature of some of the chemistry involved may render the Blue approach beyond the grasp of all but the gifted tenth grader. However, as an advanced biology course following a course in chemistry this version has true potential. Vocabulary of texts and laboratory manuals consists of many technical terms uncommon in current texts, but due to the de-emphasis of taxonomy there are comparatively fewer terms and scientific names. Relatively few photographs but numerous excellent line drawings and diagrams, all in black and white, are included where pertinent, and aid in obtaining a better understanding of the text material. The laboratory manuals correlate well with the text material. The emphasis in laboratory work is placed on student investigation and experimentation. The wealth of excellent experiments designed to illustrate how the biologist works places more importance on laboratory work than is presently found in biology courses. The Teachers' Guides are essential. They advise and guide the teacher with pertinent information and recommendations toward the successful completion of the laboratory exercises. In order to fully appreciate the value of this proposed program, every biology teacher should carefully examine each of the nine volumes.

JOSEPH P. VAUGHAN
Brunswick High School
Brunswick, Maine

The Doubleday Pictorial Library of Science: Chemistry, Physics, Astronomy. J. Bronowski, Gerald Barry, James Fisher, and Julian Huxley (Editorial Board). 368p. \$9.95. Doubleday and Company, Inc., 575 Madison Ave., New York 22, N. Y. 1960.

Starting with the premise that "the most exciting discovery that a human being makes is that knowledge is interesting," this library of science presents an intriguing array of information from chemistry, physics, and astronomy in a systematic and profusely illustrated fashion. The volume is designed primarily for young people and contains 855 paintings, drawings, photographs, and

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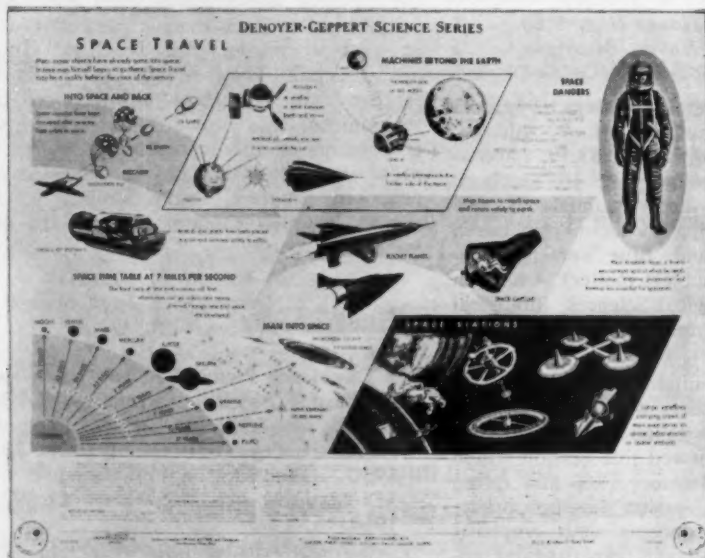
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or Exploring the Universe, among others is a page or more of pertinent data. Many suggestions are made for experiments, observations, and activities such as telescope making. A glossary of 1000 useful science words and an exhaustive index adds to the usefulness of the volume. The editors have drawn upon more than a dozen distinguished scientists for contributions to this library and have conferred with educators from a number of countries in its preparation. The book stands as a unique and valuable addition to the literature of science for youth and the layman, useful in the home and in school from the upper elementary grades through high school.

HERMAN KRANZER
Temple University
Philadelphia, Pennsylvania



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BOOK BRIEFS

A History of Science, Technology and Philosophy in the Eighteenth Century. Volumes I and II. A. Wolf. Second Edition. Revised by D. McKie. 798p. Complete \$5. Harper and Brothers, 49 East 33rd St., New York 16, N. Y. 1961.

Narrates the advancements made during the eighteenth century in the various scientific fields of endeavor. Gives a brief biographical sketch of outstanding people and their contributions. Included also are procedures followed in experiments and diagrams of pieces of apparatus used or invented. The broad fields covered include astronomy, botany, building technology, chemistry, geography, geology, marine instruments, medicine, meteorology, mining and metallurgy, mechanical calculation, physics, power plants and machinery, psychology, philosophy, social sciences, transportation, telegraphy, and zoology. A welcome edition as a ready reference to be used in the library of a science or social studies teacher.

PSSC Teacher's Resource Book and Guide. Physical Science Study Committee authors. 800p. Complete Set \$10. Parts not available separately. D. C. Heath and Company, 285 Columbus Ave., Boston, Mass. 1960.

This guide may be the answer to the introduction of PSSC Physics in school systems where teachers have not attended PSSC Institutes. Divided into 4 parts and each part has a section giving a commentary on the PSSC Physics text (white pages); problems at ends of chapters from PSSC Physics text are analyzed with solutions given (green pages); a discussion of the experiments in the PSSC Laboratory Guide, answers to questions in the Guide with suggestions for additional experiments (yellow pages). Part I covers fundamental physical ideas of time, space, and matter. Part II discusses light and wave motion. Part III includes dynamics, hence includes discussion of force, mass, momentum, and energy. Part IV concerns itself with electricity, magnetic fields,

and the structure and physics of the atom. Recommended to high school physics teachers who wish to be alerted to new developments. In effect, these are a requirement in a system which proposes to initiate PSSC Physics as a part of the high school curriculum. Each of 4 parts is provided with pressboard binder, 8½" x 11" punched pages, and three metal rings. Parts not available separately.

The Amazing World of Medicine. Helen Wright and Samuel Rapport. 302p. \$3.50. Harper and Brothers, 49 East 33rd St., New York 16, N. Y. 1961.

The authors have written a fascinating book about medical men who have made great pioneering discoveries in medicine. The book should make students aware of the heroism, idealism, and self-sacrifice of the men who make up the world of medicine. Such chapters as: Victory Over Pain, Field Hospital—World War I, Spare Parts for Defective Hearts, and Twenty-four Hours in a Cancer Hospital will appeal to interested high school students.

Simple Science Experiments. Harold Visner and Adelaide Hechtlinger. 232p. \$4.80. Franklin Publishing Company, Inc., Palsade, N. J. 1960.

Contains 210 experiments, 70 for each grade, which the authors have evaluated as appropriate for each of three grade levels (4, 5, and 6). Commonplace materials are suggested for each exercise. Individual exercises represent earth science, physics, biology, and chemistry. Each exercise contains appropriate title, a list of materials needed, a suggested procedure, and an explanation. Vocabulary well chosen. Black and white line drawings as illustrations. Useful to youngsters in intermediate grades.

Understanding Light. Beulah Tannebaum and Myra Stillman. 144p. \$3. Whittlesey House, McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y. 1960.

An introduction to the phenomenon of light. Some of the topics include how the distance to the sun is measured, structure of the sun, sunspot activity, how the sun's energy is produced, measurement of the speed of light

by Roemer, Fizeau, Michelson, Bearden and Thompson, and others; also the pinhole camera; principles of reflection and refraction; mirages; lenses and image formation; the spectrum; the corpuscular, wave, and quantum theory of light; wave lengths of light; the structure of the eye and sight; eye defects; luminescence; radar; radio telescopes; electron microscopes; etc. Pleasant reading and well illustrated. Recommended as supplementary reading for junior high school students or as interesting reading material for laymen.

On the Various Forces of Nature. Michael Faraday. 106p. 95¢. The Viking Press, 625 Madison Ave., New York 22, N. Y. 1960.

A series of lectures delivered by the famed scientist to a group of boys and girls assembled at the Royal Institution. Preserves the exact wording and illustrations found in the rare early editions. Though a century has passed, the thrill of discovery and sharing is as unforgettable now as in the time of the Victorian period.

From Cell to Test Tube. Robert W. Chambers and Alma S. Payne. 216p. \$3.50. Charles Scribner's Sons, 597 Fifth Ave., New York 17, N. Y. 1960.

An introduction to biochemistry written in terms which the general reader with limited or no scientific background can understand. Some of the explanations given are of fermentation, enzymes, the chemistry of proteins, enzyme specificity, carbohydrate metabolism, the mechanics of digestion, amino acids, hormones, vitamins, and nucleic acids. Generally, the subject is introduced historically and is developed to the present time. Presented in a way that makes interesting reading and recommended as supplementary reading for secondary school pupils in science or nonscience classes.

The Microscope and How to Use It. Georg Stehli. 158p. \$3.75. Sterling Publishing Company, Inc., 419 Fourth Ave., New York 16, N. Y. 1960.

Introduces the students to: the parts of the microscope, the use of the microscope, examination of simple preparations, exploration of a drop of water, the structure of a flower, bacteria, microphotography, and microtome techniques. An excellent book both for the biology teacher's personal library and for the high school library.

The Quest of Isaac Newton. Barbara and Myrick Land. Illustrated by Arthur Renshaw. 56p. \$2.50. Doubleday and Company, Inc., 575 Madison Ave., New York 22, N. Y. 1960.

An easy-to-read book. Topics include: analyzing the rainbow, a new way to think, one law for all the universe, the way things move, the magic of numbers, the mystery of light, and Newton's work in our time. Recommended for the upper elementary and junior high school. It provides an insight into the life and work of a great scientist.

Under the Sea. Maurice Burton. 232p. \$4.95. Franklin Watts, Inc., 575 Lexington Ave., New York 22, N. Y. 1960.

One of the illustrated Science Books Series. Divided into five parts: One deals with the

origin of life in the sea; the second deals with relationships of life in the sea; the third introduces types of animals and plants; and the fourth discusses zones of the sea. The final section introduces the types of investigation in the sea. Well illustrated and informative. A good addition to a science library. Serves as a basic source for factual information in oceanography.

Careers in Science, Mathematics, and Engineering, A Selected Bibliography. A. Neal Shedd, Anita K. Scott, and James M. McCullough. 40p. 25¢. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 1961.

An annotated bibliography of 385 titles of free and inexpensive science career guidance printed materials and films. Indexed under seven major headings: Agriculture, Biological Sciences, Engineering, Forestry, Health Professions, Mathematics, and Physical Sciences. Annotations complete, concise, and very useful. Should be available in every school guidance office. Science teachers, grades 8-12, would find it useful in performing their career guidance function.

Here Comes the Bees! Alice E. Goudey. 94p. \$2.50. Charles Scribner's Sons, 597 Fifth Ave., New York 17, N. Y. 1960.

An excellent source of material on bees for pupils in the lower and middle elementary grades. Explains accurately, in detail, and in simple language the social life of the bees in the hive. Book is written in story form and will be interesting reading to young people. It is also well illustrated and in large print.

What is Space? Matthew F. Vessel and Herbert H. Wong. 14p. 75¢. Fearon Publishers, 2263 Union St., San Francisco, Calif. 1959.

A paperback book which emphasizes content and methodology for teaching children about space. Characteristics of space such as airlessness, decreased pressure, temperature changes, darkness, and weightlessness are

stressed. A list of space concepts is included. Well illustrated. Recommended for elementary school level.

Journey into Space. Matthew F. Vessel and Herbert H. Wong. 14p. 75¢. Fearon Publishers, 2263 Union St., San Francisco, Calif. 1959.

A selection which emphasizes content and methodology for teaching children about space flight. The content includes information on how rockets get off the earth, how rockets work, living in a space ship, and the return to earth. A list of space concepts is included. Well illustrated. Recommended for elementary school level.

Messages from Space. Clive E. Davis. 86p. \$2.75. Dodd, Mead and Company, 432 Fourth Ave., New York 16, N. Y. 1961.

About satellites and the scientific information they may discover. Additional sections of the book are devoted to methods of tracking satellites. The last part describes a proposed space trip of an astronaut. (This now, of course, is a type of post-mortem.) Well illustrated. Recommended for junior high school level.

The Human Frame. Giovanna Lawford. 110p. 95¢. Doubleday and Company, Inc., 575 Madison Ave., New York 22, N. Y. 1961.

A new publication that shows the human skeleton in a series of simple, clear, and accurate drawings. Included is a series of 39 line drawings. The drawings show the parts of the head, vertebrae, the torso, arms, legs, and of the entire body.

Wonders of the World Between the Tides. Norman Hammond Wakeman. 64p. \$2.95. Dodd, Mead and Company, 432 Fourth Ave., New York 16, N. Y. 1960.

For readers from upper elementary school and junior high or adults. Maintains academic approach while blending in the simple natural history of coastal tidal animals.

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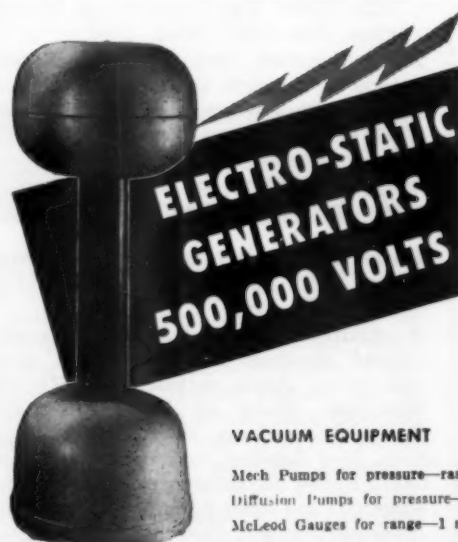
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Find a Career in Education. Frances Smith. 160p. \$2.75. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1960. Author discusses the many aspects and opportunities in the field of education. A panorama of positions is presented ranging from custodial work to responsibilities of the superintendent of schools. Book is written for students of an approximate age level 11-15 years. Although no attempt is made to "paint the picture" in favor of, or against, a career in education, the author's implicit objective is to familiarize young people with the advantages as well as the needs for im-

provement in some areas of work in education. The book should encourage the reader to consider a career in education. Good book for guidance counselors and Future Teachers of America sponsors to have available to inform prospects in the teaching field.

The Wellsprings of Life. Isaac Asimov. 200p. 50¢. Mentor, The New American Library of World Literature, Inc., 501 Madison Ave., New York 22, N. Y. 1960. Asimov writes a history of science directed to determining the source of life. He traces

the theory of evolution from Genesis to date; he examines biochemistry for the elusive answer. Redi, Van Leeuwenhoek, Pasteur, and a host of more recent notables make their contributions to keep Asimov on the path to the wellspring of life. For the advanced secondary student and the general reader interested in science.

Space Biology, the Human Factors in Space Flight. James S. Hanrahan and David Bushnell. 236p. \$6. Basic Books, Inc., 59 Fourth Ave., New York 3, N. Y. 1960. A survey of forces affecting man's survival during space travel. A timely book which traces man's speculations on the possibility of space travel. Points out the hazards of man's existence in space. Discusses experiments to examine the effects of extremes in acceleration; weightlessness; atmospheric pressure; cosmic and other radiation. Proposals to deal with these hazards, as well as man's normal biological needs, during space travel are set forth. In the conclusion the authors discuss the effect of space travel on such factors as religion, arts, education, economics, and government. Of primary interest to adults, this book would be understood and enjoyed by high school students.

Atoms to Galaxies. James Stokley. 362p. \$6. The Ronald Press Company, 15 East 26th St., New York 10, N. Y. 1961.

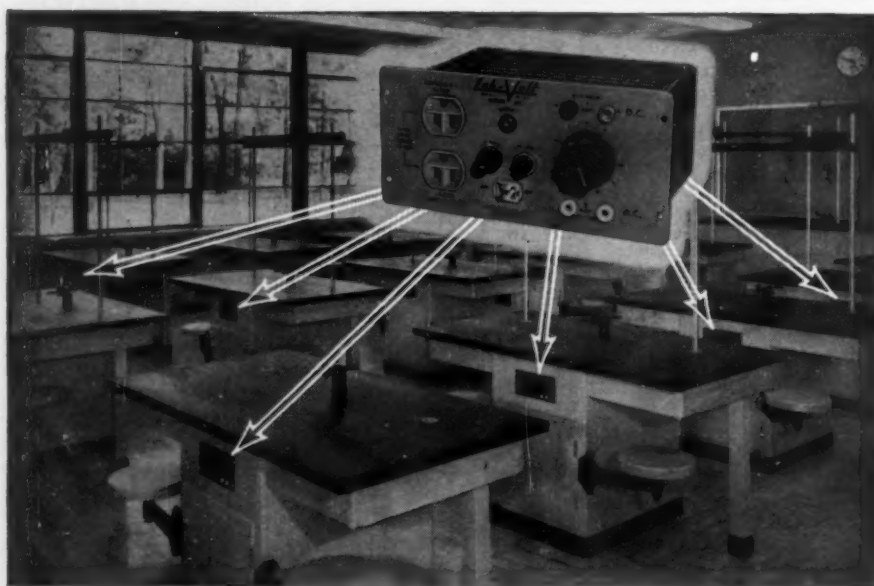
A new approach to modern astronomy via the microscopic to the macroscopic. This volume surveys the universe with the more modern tools of the astronomers. Structure of matter, spectroscopy, radio astronomy, and atomic changes in the sun serve to give a new look at the question of life on other planets, and the theories of evolution of the universe. Artificial satellites and space flight are not overlooked. Designed for the general reader, it would help the teacher answer questions of current interest in the new developments of the aerospace field.

IGY: Year of Discovery. Sydney Chapman. 112p. \$4.95. The University of Michigan Press, Ann Arbor, Mich. 1960.

An informative book on some scientific aspects of the earth and sun in special connection with the International Geophysical Year 1957-58. Should engage the attention of every person who has an interest in the natural phenomena of the world and the environment in which he lives.

Ducks, Geese, and Swans. Herbert H. Wong. 66p. \$2.95. Lane Book Company, Menlo Park, Calif. 1960.

A children's science book with excellent colored drawings of many ducks, geese, and swans. Areas include: Our Thrilling Waterfowl, Food of Waterfowl, About Swans, About Geese, About Ducks, Migrations, Bird Banding, and Protecting Waterfowl. Refers to differences between these waterfowl and other waterbirds of the North American continent. Describes characteristics, appearance, and importance of fowl to man. The latter chapters give generally, habits, range, and migration. Book would be valuable in gaining knowledge needed at the elementary level.



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PROFESSIONAL READING

"Science Teaching Objectives and Methods." By J. Darrell Barnard. *The Welch Physics and Chemistry Digest*, 2:14. 1961. Traditional objectives of science teaching are contrasted with the currently accepted objectives. The author cites research that has led to the formulation of current objectives. The author states that "There is no one method of teaching science." Why this is true is discussed.

"California Sets Standard for Teachers." *Chemical and Engineering News*, 39:25. July 3, 1961. The highly controversial California Fisher Education Bill is now a law. Involving basic changes in teacher certification requirements and curriculum changes for training programs, the new law was passed through the general assembly by a considerable majority, according to this article. An excellent source of information for all professional educators.

"Current Activities in Elementary and Junior High School Science." By Dorothy C. Matala. *School Science and Mathematics*, 61:339. May 1961. There are four parts to this article. The first deals with a brief history of science education, the second gives a detailed account of the activities in Iowa ("... because I am most familiar with these and they appear to be rather typical in scope and approach..."). A summary of science activities for K-9 grade levels from nineteen states and the special projects and activities that are included "... for the newness of their approach..." make up the third and fourth parts. The report concludes with a list of problems relating to curriculum, methods, and personnel, that need to be solved. The author includes at the end of the article "A Statement of Bices." This, according to the author, gives the frame of reference which was used to select the material included in order to complete the report.

AUDIO-VISUAL AIDS

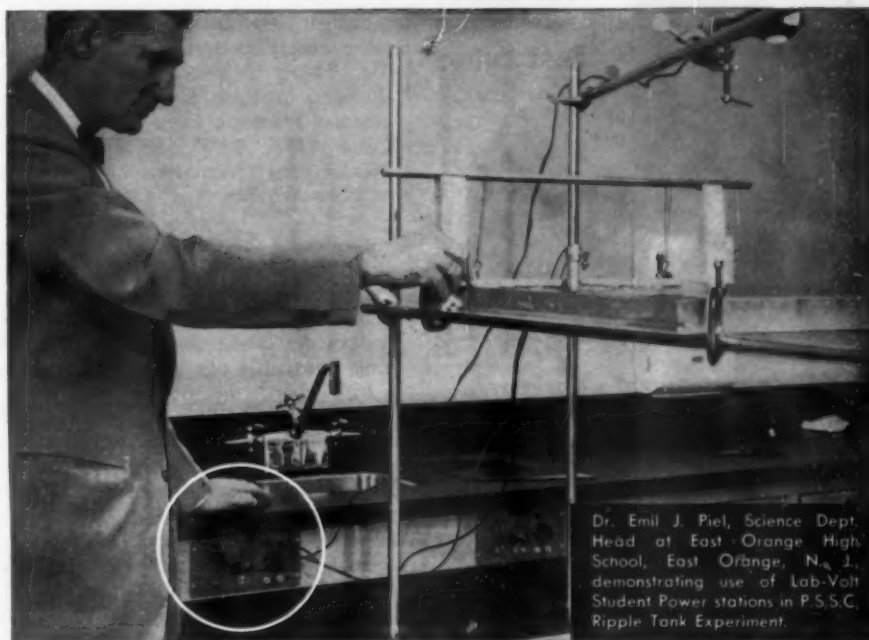
Indians: Indians—How They Lived. The film mainly covers the different utensils used by Indians. It begins with those used for eating and then continues with pottery, arms, and also the types of living quarters. Gives a good display of Indian artifacts and an excellent presentation of their uses. Designed especially for grades one to three. Useful in integrating social studies and science in elementary grades. 16 min. Color \$120, B&W \$60. 1961. Cenco Educational Film Company, 1700 West Irving Park Blvd., Chicago 13, Ill.

Science Filmstrips for Elementary Classes. New set of eight elementary filmstrips all in color. Titles are: *How We See and Hear*, 33

frames; *Life Story of a Butterfly*, 39 frames; *The Wonders of the Snow*, 38 frames; *How Does a Garden Grow?* 39 frames; *Our Desert Treasure*, 34 frames; *Miniature Plants of the Desert*, 35 frames; *Wealth in the Ocean*, 39 frames; *The Wonder of Crystals*, 39 frames. Youngsters in a beginning junior science museum program were shown and enjoyed the series including *The Wonder of Crystals* which is for upper elementary and secondary pupils. The presentation, through the use of color and artwork, motivates youngsters to ask questions. Teachers need to be prepared with answers. Parents who viewed these filmstrips were excited about these valuable visual aids for improved

learning-teaching situations. Color. Set of 8, \$44; 1-4 strips, \$6 each. 1961. Moody Institute of Science, Box 25575, Los Angeles 25, Calif.

Battle of the Bugs: How Nature Controls Insect Pests. Colorful action photography catches aphids and ladybird beetles. Both are shown in a backyard setting. Larval and pupal stages are emphasized. The parasitic wasp, syrphid fly, and green lacewing are shown destroying aphids. Home setting cleverly stresses the need for controlling the "bugs." For grade 4 and above. 11 min. Color \$110. 1960. Ken Middleham Productions, P.O. Box 1065, Riverside, Calif.



Dr. Emil J. Piel, Science Dept. Head at East Orange High School, East Orange, N. J., demonstrating use of Lab-Volt Student Power stations in P.S.S.C. Ripple Tank Experiment.

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Wonders in a Country Stream. Film opens up to boys and girls a new world of animal life that lives in streams. It shows how many animals adapt to be able to survive, how they build their homes, and how they grow. The newts, frogs, turtles, and caddis fly are included. Helpful in making the student more observant and appreciative of animal life. There is a companion film entitled *Wonders in Your Own Backyard*. For elementary science classes, grades 2-7. 10 min. Color \$110, B&W \$60. 1960. Churchill-Wexler Film Productions, 801 North Seward St., Los Angeles 38, Calif.

Exploring the Ocean. Knowledge we have about the region below the surface of the ocean and how we have obtained the information is introduced through animation and underwater photography. Historical beginning sets forth the idea "nothing more to learn" about the ocean, which the film rapidly dispels. Tools of the oceanographer, ocean life, mineral wealth, continental shelves, and the ocean floor are displayed. Limitations of our knowledge are set forth in the various areas. Methods of extraction of minerals from sea water are illustrated. Correlated with Heath Science Series, "Far and Near" (grade 3). For middle grades. 11 min. Color \$110, B&W \$60. 1960. Churchill-Wexler Film Productions, 801 North Seward St., Los Angeles 38, Calif.

Airplanes Work for Us. Film provides opportunity to correlate social studies and science in a unit such as transportation. Many common and unusual applications of airplanes and flight demonstrated. Shows airplane's function in carrying both mail and passengers. Some other less well-known functions of airplanes also shown. These include: fire patrol, rescue work, weather patrol, moving heavy machinery, setting power lines, and crop dusting. Recommended for grades 4-6. 11 min. Color \$110, B&W \$60. 1960. Churchill-Wexler Film Productions, 801 North Seward St., Los Angeles 38, Calif.

Arthropods: Insects and their Relatives. Somewhat traditional, straight, factual treatment of subject. The film shows structural characteristics used in classification of the phylum. Many examples, using excellent choice of illustrative species to demonstrate clearly the four main subdivisions of the phylum. Illustrates wide variety of forms: lobsters, grasshoppers, spiders, millipedes citing their beneficial and harmful forms. Good treatment of unique characteristics of honey bee, silkworm moth, and clothes

moth. Recommended for junior high science and biology classes. 11 min. Color \$110, B&W \$60. 1960. Coronet Instructional Films, Coronet Building, Chicago 1, Ill.

Heat and Its Behavior. The nature of heat and how it is utilized. Explains that heat is a form of energy, and that the sun is the ultimate source of our heat. Some of the more important sources of heat are given such as electricity and the combustion of gasoline, wood, and natural gas. The change in molecular motion and the resulting change with the addition of heat, is shown through the use of animated drawings. The transfer of heat by means of conduction, and radiation is also shown. For grades 4-9. 11 min. Color \$100, B&W \$50. 1960. Coronet Instructional Films, Coronet Building, Chicago 1, Ill.

Animal Homes. A variety of homes of different animals are shown. The film shows how animals such as birds, ants, spiders, and moles use their homes for shelter, food storage, and the raising of young. The photography and narration are excellent. Film can be used in all elementary science classes. Also suitable for junior high science classes. 11 min. Color \$110, B&W \$60. 1960. Churchill-Wexler Film Productions, 801 North Seward St., Los Angeles 38, Calif.

An Introduction to Jet Engines. Produced by National Film Board of Canada as a training film for the Royal Canadian Air Force. Animation using pictures of a ball, a compressed spring, and a container demonstrates Newton's Third Law. Illustrates the working principles of the Ram jet engine, the turbojet engine, and the turboprop engine. Shows development in turbojet engine of forward thrust by examining the compression, expansion, and release of gases. Both centrifugal and axial-flow engines graphically illustrated. Excellent discussion of operation of turboprop, and turbojet engines. Recommended for high school physics. 15 min. Color \$175, B&W \$90. 1960. Text-Film Department, McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y.

Let's Build a House. An amusing and educational film to accompany the Heath Science Series. Designed for smaller children. Through a story-like presentation utilizing two children plus father in the project of building a toy house, the properties and uses of various building materials are demonstrated including concrete, wood, iron, and glass. Unique way of demonstrating science concepts using familiar things in a situation appropriate to a young child's experience-level. 11 min. Color \$110, B&W \$60. 1960. Churchill-Wexler Film Productions, 801 North Seward St., Los Angeles 38, Calif.

Copper Mining. A good film showing copper from the time it is taken as ore to final 99-per cent pure blister bars. Steps in process are well illustrated. Covers mining and the drilling operation and blasting to expose ore. Use of power equipment in total operation portrayed. Shows crushing of ore

in mill, flotation process, and filtration process to produce concentrate and remove impurities. Animation and live action show processes in the reverberatory furnace and converter. Good photography takes viewer through final steps in process in which additional impurities in form of slag and combined gaseous wastes are removed. Recommended for junior high school general science and earth science. Might be useful in chemistry if teacher is familiar with chemistry of the process which is not described in detail. 14 min. Color \$135. 1960. Pat Dowling Pictures, 1056 South Robertson Blvd., Los Angeles 35, Calif.

Volume and Its Measurement. Spatial relationships are illustrated through three-dimensional plastic models. The cubic unit is compared to square units. Volumes of prisms, pyramids, cylinders, and cones are found both by actual measurement and by the use of mathematical formulae. Specifically, volume is determined by the formula $V = l \times w \times h$, or $V = Bh$. This relationship is also shown graphically using wooden blocks. In the determination of the volume of a cylinder the formula $V = Bh$ ($\text{Area of base} = \pi r^2$) is used. Comparisons of the volumes of a rectangular prism and a pyramid, and a cylinder and a cube, each with the same base and height is made. The formula $V = \frac{1}{3} Bh$ is not derived but is determined by direct measurement of water poured from the pyramid into rectangular

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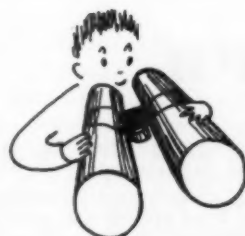
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container, and then from the cone into the cylinder. Explanations given are clear. For grades 7-9. 11 min. Color \$100, B&W \$50. 1960. Coronet Instructional Films, Coronet Building, Chicago 1, Ill.

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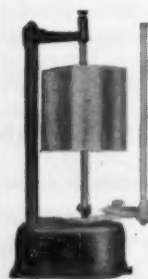
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Distance Measuring Instruments Kit, No. 600. This is another of the kits developed by the Physical Science Study Committee. It contains material for making three instruments for measuring large and small distances. The range finder is calibrated experimentally to provide insight into the nature of an instrument scale. It measures distances satisfactorily to 30 meters. The parallax viewer is calibrated mathematically and does require a knowledge of the principles involved. Its effective range is about 1500 meters. The optical micrometer is also calibrated experimentally. This instrument has a sensitivity such that a thickness of .03 mm is indicated as 3-mm change on the marking scale. Used with PSSC experiments 1-2(40) and 1-3(50), these devices present for the student a new approach to measuring distances, both large and small. The instru-

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CAPACITY 311 Gram
SENSITIVITY .01 Gram

THE POPULAR

Cent O Gram

An unbeatable balance for general laboratory weighings, specific gravity work, and preweighing, the CENT-O-GRAM is an accepted pace setter in its field.

As well as being portable, this balance is adaptable for use in many fields.

The 311 gram capacity is higher than any balance of its type through use of two 100 gram self stored attachment weights.

Comes equipped with stainless steel bows, pan (3-3/4" dia. x 1/2" deep) and specific gravity platform.



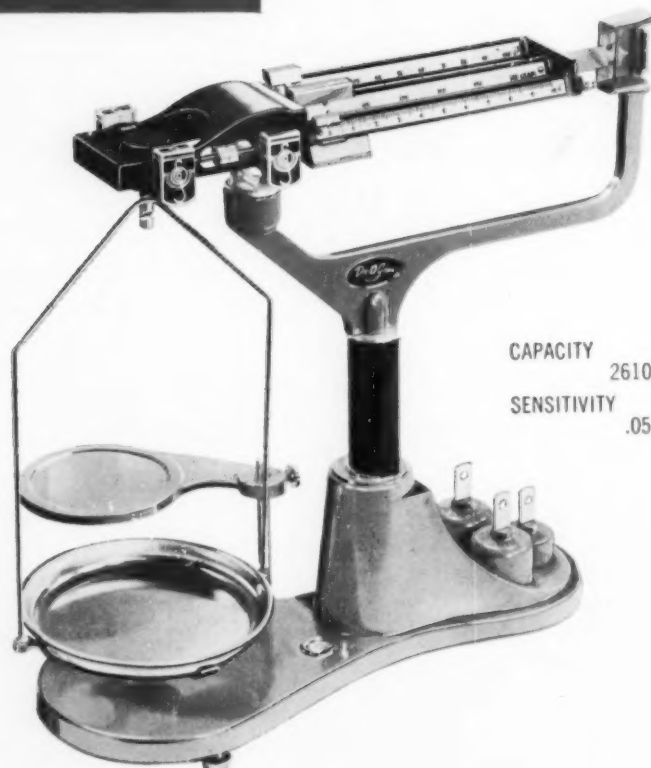
THE ALL NEW

Dec O Gram

This latest OHAUS overhead triple beam balance has a capacity of 2610 gram.

Such other familiar OHAUS features as sturdy box end beam, sliding type poise with center indicating panel, self aligning bearings, self storing attachment weights and specific gravity platform, all add up to fast sensitive high capacity performance.

Available in two models... the Model 3600 (metric) and Model 3601 (avoirdupois).



CAPACITY 2610 Gram
SENSITIVITY .05 Gram

OHAUS SCALE CORPORATION
1050 COMMERCE AVENUE UNION, NEW JERSEY